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TWENTY-SIXTH ANNUAL REPORT

of

Pasture Research

in the

Northeastern United States
University Park, Pennsylvania

1962

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1962

Twenty-sixth Annual Report
of
Pasture Research
in the
Northeastern United States

U. S. Regional Pasture Research Laboratory
University Park, Pennsylvania
Forage and Range Research Branch
Crops Research Division,

Northeast Branch
Soil and Water Conservation Research Division,
and
Grain and Forage Insects Research Branch
Entomology Research Division
of the
Agricultural Research Service
U. S. Department of Agriculture

and

The Agricultural Experiment Stations
of the
Twelve Northeastern States
Cooperating

- - - - -

Copies of this report were sent to all organizations involved in the development of the present pasture research program in the twelve Northeastern States and in addition to some institutions outside the Region where grassland research is a major interest.

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B.

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* * * * *
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TABLE OF CONTENTS

	Page
Introduction -----	1
Personnel changes at the Pasture Laboratory -----	1
Collaborators' conference -----	1
Research at the Pasture Laboratory	
Genetics, pathology and entomology -----	2
Alfalfa -----	2
Creeping-rooted -----	2
Genetic markers, inheritance -----	2
Pollen-tube growth and temperature -----	2
Disease resistance, development -----	3
Resistance to leafspot, recurrent selection -----	3
Root rot of alfalfa and red clover -----	4
Leafhopper resistance, selection for -----	4
Red clover -----	4
Longevity, increase by controlling weevils and root rot -----	4
<u>Fusarium</u> root rot and larval injury by <u>Calomycterus</u>	
<u>setarius</u> -----	5
Internal breakdown -----	5
In tiller-plants -----	6
In strawberry clover -----	6
Anatomical study -----	6
Selection for persistence -----	6
Orchardgrass -----	6
Breeding -----	6
Male sterility -----	7
Non-heading -----	7
<u>Lolium-Festuca</u> hybrids -----	8
Selection for fertility -----	8
Cytogenetics of Kentucky hybrids -----	8
Bromegrass -----	9
Selection with leaf disease resistance -----	9
Micronuclei in quartets and temperatures -----	10
Ryegrass -----	10
Interspecific hybridization -----	10
Tall fescue -----	11
Genome homologies and meiosis -----	11
Biochemistry, physiology and soils -----	12
Carbohydrate studies on grasses -----	12
Feeding value of forages, measurement by chemical analysis -----	12
Climate at State College -----	13
Climate studies (cooperative with 10 states in NE-29) -----	14
Legume and grass seedling establishment -----	14
Orchardgrass, growth affected by reserves, cutting height,	
and recovery under 2 light intensities -----	15
Alfalfa, creeping-rooted, physiological studies -----	16
Ladino clover, establishment in orchardgrass sods -----	16

Allelopathy in orchardgrass sods -----	17
Specificity of competition -----	17
Alfalfa in association with quackgrass -----	18
Phosphorus fertilization of grasses and legumes -----	18
Phosphorus withdrawal and growth curve of ladino clover seedlings -----	18
Response to phosphorus when other nutrients are not limiting -----	18
For red clover in acid, phosphorus deficient soil -----	19
Iron availability to orchardgrass in nutrient culture -----	20
Defoliation and root growth in orchardgrass -----	20

Research at Beltsville, Maryland

Phosfon and growth of alfalfa -----	21
Alfalfa weevil -----	21
Insecticidal control -----	21
Biological control and ecology -----	22
Plant resistance -----	22

Reports of R. and M. Cooperative Research

NE-9 - Introduction, testing, multiplication, and preservation of potentially valuable plants for crop improvement and industrial use -----	23
NE-13 - Physical properties, behavior, and forms of forage as related to engineering application -----	24
NEM-22 - Facilitating marketing of seeds through improved testing procedures -----	25
NE-24 - Nutritive evaluation of forages -----	27
NE-28 - Breeding and evaluation of improved varieties of forage crops adapted to the Northeast -----	29
NE-29 - Management and productivity of perennial grasses -----	32
NE-35 - Analysis of northeastern climatic variables and their relationships to plant response -----	33
NE-43 - Profitability of alternative forage systems for Northeast dairy farms -----	35
NE-45 - Root and crown diseases of alfalfa and clovers -----	36
Physical and biological environments, role in disease development -----	37
Plant constitution and development of root and crown diseases -----	38
NE-48 - Soil-plant-water relationships -----	39

Research at State Stations

Connecticut (Storrs)

Nitrogen, high rates, and irrigation, effects on yield and chemical composition of grasses -----	40
Fertilizer, high rates, applied to alfalfa -----	40
Lime, rates and sources -----	41
Weed control -----	41

F.

Delaware

Orchardgrass, cutting heights, nitrogen fertilization and irrigation, effects on survival and root and dry matter yields -----	41
--	----

Maine

Alfalfa seedlings, productivity -----	42
Topdressed potassium, uptake by alfalfa and timothy -----	43
Forage handling systems for dairy farms -----	43

Maryland

Red clover breeding -----	44
Forage crop evaluation -----	44
Ladino clover breeding, diseases, and insects -----	44
Insect investigations -----	45
Sod seeding establishment -----	45
Soil temperature and forage growth -----	46
Summer annuals and management -----	46
Bermudagrass, response to potassium and nitrogen -----	47
Midland bermudagrass, response to 2 sources of nitrogen, 3 rates of nitrogen and 3 levels of lime -----	47
Midland bermudagrass, effects of source of nitrogen and number of applications on dry matter production and nitrogen recovery -----	48
Midland bermudagrass, clipping heights and frequency of harvest, effects on performance -----	48
Midland bermudagrass, nitrogen rates and clipping frequency, effects on performance -----	49
Orchardgrass, response to sources of nitrogen and time of application -----	49
Legume-grass mixtures in relation to differential nitrogen fertilization -----	50
Forages, growth and development as affected by potassium -----	50
Summer annual pastures for lactating cows -----	51
Grasses, nitrogen-fertilized, compared with grass-legume mixture for lactating cows -----	51
Grass-legume combinations for beef production -----	52

Massachusetts

Nitrogen, rates of, and harvest management, effects on yields of orchardgrass -----	52
Forage crop insects -----	53
Census -----	55
Control -----	56
Parasites on alfalfa weevil -----	57

New Hampshire

Smooth brome grass, red clover, and alfalfa -----	58
White clover -----	58

New Jersey

Silage investigations -----	59
Herbicides and Midland bermudagrass -----	60
Pasture fertilization -----	60
Pasture renovation -----	61
Forages, extraction of potassium from soils with varying potassium supply capacity -----	61

Nitrogen X potassium X grass species interactions -----	62
Midland bermudagrass, fertilization -----	63
Grass fertilization studies -----	63
Alfalfa production, influence of calcium saturation on exchange complex and fertilization of Dutchess (Nassau) soil---	64
Grass yields and heavy nitrogen fertilization -----	65
Milk production of dairy cows fed nitrogen-fertilized orchardgrass compared to alfalfa -----	66
<u>New York (Cornell)</u>	
Breeding and cytogenetic investigations -----	66
Breeding and strain evaluation for improved feeding value, yield, and seasonal distribution -----	67
Grasses -----	68
Feeding trials -----	68
Breeding and evaluation of improved varieties -----	69
Alfalfa weevil -----	70
Grasshoppers and pea aphids -----	71
Grass insects -----	71
European chafer -----	72
Meadow spittlebug -----	72
Tarnished plant bug -----	73
Virus diseases of legumes -----	73
<u>Pennsylvania</u>	
Genetics and improvement of perennial forage legumes -----	74
Cytogenetics and forage crop species and species hybrids -----	74
Genetics and improvement of forage grasses -----	75
Root and crown diseases of forage legumes -----	76
Birdsfoot trefoil, establishment and maintenance -----	76
Maintenance fertilization of grasslands -----	77
New forage varieties and species, evaluation for dairy pastures -----	78
Forage, utilization by beef cattle -----	79
Sorghums, sudangrass, and millets, evaluated for feed production -----	80
<u>Rhode Island</u>	
Forage crop establishment -----	81
<u>Vermont</u>	
Forage crop insects, relative importance and control -----	81
Trefoil, winter kill -----	81
Trefoil, sheep grazing trials -----	82
Grass, nitrogen studies -----	83
Lotus species and species hybrids, embryo culture -----	83
<u>West Virginia</u>	
Root rots of forage legumes, factors influencing losses-----	84
Grasses, diseases -----	84
Alfalfa insect control -----	84
Alfalfa, varieties grown under different climatic conditions, and fall cutting -----	86
Biochemical studies on cold resistance of alfalfa -----	87
K fertilizer, rate and time of application in relation to yield and longevity of alfalfa stands -----	87

Useful Techniques

Self-irrigating greenhouse pots -----	88
Materials for porous wall root segregation -----	88
Water bath for reducing soil temperatures -----	88
Soft stem cuttings of <u>Trifolium medium</u> -----	89
List of publications -----	90

PASTURE RESEARCH IN THE NORTHEASTERN UNITED STATES

This report, the twenty-sixth in the series, was prepared by and is intended primarily for use of personnel engaged in forage research in the twelve Northeastern States. It contains a summary of progress during 1962, reflects an appraisal of problems and provides information that should benefit all cooperating states. Included are reports from research scientists at the U. S. Regional Pasture Research Laboratory, from the northeast forage crops technical committees, from research workers at the state experiment stations and from personnel of the Forage and Range Research Branch and the Grain and Forage Insects Branch, Beltsville, Maryland.

Collaborators assembled materials from their respective stations, chairmen of regional technical committees supplied reports of their activities on forage problems and scientists at the Pasture Research Laboratory and leaders at Beltsville prepared reviews of their forage research related to this region.

In February Dr. Donald K. Barnes joined the staff as geneticist to work on alfalfa. He received training at the University of Minnesota prior to completion of graduate studies at The Pennsylvania State University where the Ph.D. degree was conferred. Dr. Donald Burdick, assistant in chemistry resigned in June to accept a position in the Eastern Utilization Research and Development Division at Philadelphia, Pa. and Mr. E. S. Titlar, technician in chemistry resigned in December to continue graduate work.

A Collaborators' meeting was held at University Park September 10 and 11, 1962. During the administrative conference held here in September 1961 the Collaborators suggested "Diseases and Insects" as the subject for a meeting in 1962, and two months later development of the program was started. Above and belowground diseases and insects were presented by panels of scientists from the various states and specialists from Beltsville and the Pasture Laboratory. The more important plant pests, work in progress, problems and results at different locations under various conditions received primary attention. Included were discussions of better means and methods that could lead to more cooperative work between states and with A.R.S. and the Pasture Laboratory.

In the business meeting Dr. W. H. Mitchell from Delaware was elected chairman and Dr. H. B. Couch from Pennsylvania, secretary. It was decided that the Executive Committee would determine wishes of the Collaborators relative to a theme and suggested date for the next meeting.

RESEARCH AT THE PASTURE LABORATORY

GENETICS, PATHOLOGY AND ENTOMOLOGY

Alfalfa

Creeping-rooted Alfalfa

Two previously established creeping-rooted alfalfa nurseries were observed in 1962. A three year-old nursery established in 1959 showed only a small increase in the percent of creeping-rooted plants over the previous year's data. On the basis of three years' data, 20 plants were selected for vigor, degree of root-spreading and lack of extreme fall dormancy. These plants will be incorporated into the program to increase disease and insect resistance into creeping-rooted alfalfa. As part of the long-range program, the 2400 plant nursery established in 1961 was observed and rated for creeping-rooted plants.

Inheritance of Seven Genetic Markers in Alfalfa

In order to obtain marker genes for use in various breeding and genetic studies a program was undertaken to study the inheritance of qualitative characters in alfalfa. During 1962 inheritance studies were completed on three characters in tetraploid alfalfa and four characters in diploid forms of Medicago sativa and M. falcata. It was indicated by F₂, F₃, and back-cross data that the three tetraploid characters (luteo-virescent leaf color, absence of floral wing horns, and cream flower color) were each controlled by the nulliplex condition of a different tetrasomically inherited gene. The four diploid characters (virescent cotyledons, yellow and albino seedlings, floral vein color, and purple flower-bud color) were each controlled by the interaction of a different pair of genes. The F₂ ratios were: normal vs. virescent cotyledons (9:7), green vs. yellow vs. albino seedlings (12:3:1), presence of vein pigmentation in flower standard vs. absence (15:1) and purple bud color in yellow flowered plants vs. yellow bud color (9:7).

Effect of Temperature on Pollen-tube Growth in Alfalfa

Studies of pollen-tube growth in vitro of diploid and tetraploid alfalfa indicated that temperature markedly affected both pollen germination and pollen-tube growth. Individual plants required different temperatures for optimum pollen-tube growth and pollen germination. Differences were also observed among plants for the reaction of pollen-tube growth to various sugar concentrations at various temperatures.

Experiments were conducted on the effect of temperatures on pollen-tube growth in vivo. Preliminary data indicate significant seed production (seeds per pod and seed weight) X temperatures interactions.

Development of Disease Resistance in Alfalfa

In 1951, a project was initiated to develop alfalfa lines that would be highly resistant to Pseudopeziza medicaginis (common leaf spot) and Ascochyta imperfecta (black stem). Leptosphaerulina (Pseudoplea) briosiana and Corynebacterium insidiosum were also considered. Co-objectives were to develop or adapt appropriate techniques and methods in pathology and genetics. Plants resistant to the first two pathogens were crossed several generations onto Vernal alfalfa, using a modified back-cross method. Highly resistant plants, selected in 1959, were sent to Utah for seed increase for further evaluation. An additional test is to determine the correlation between seed yield and forage yield of the progenies.

Polycross seed of the Pasture Laboratory alfalfa clones was received from Logan, Utah in 1962. Enough seed of 75 of the 98 entries was produced to establish extensive plots at 3 locations. Additional polycross seed is available for use by plant breeders in the Region. In limited tests of the progenies (sib crosses), resistance to Pseudopeziza medicaginis and Corynebacterium insidiosum was high and tolerance to Leptosphaerulina (Pseudoplea) briosiana was evident.

Experiments are in progress to determine the correlation between forage yields and seed yields. The 1962 data indicated highly significant differences in forage yields among the 98 clones and between harvests; no clones X harvest interactions were observed. In Utah, the clones varied significantly in survival, vigor, seed yield, and plant weight.

Recurrent Selection for Resistance to Common Leafspot in Two Alfalfa Mass Selection Populations

Two broad-based populations of alfalfa, which C. H. Hanson developed by applying moderate selection pressures for many factors over a period of 10 years, are being artificially inoculated to determine if, by recurrent phenotypic selection, resistance to Pseudopeziza medicaginis can be isolated within 2 or 3 generations. After one cycle of selection the percent of plants rated resistant was increased in population A from approximately 4% to 44% and in population B from 8% to 55%.

Root Rot of Alfalfa and Red Clover

Fusarium oxysporum was frequently isolated from roots, crowns and stems of severely diseased alfalfa plants. Sometimes Rhizoctonia solani and also Pythium sp. (if a selective medium is used) were also isolated along with F. oxysporum. In greenhouse inoculations an isolate of F. oxysporum from alfalfa was moderately pathogenic to alfalfa and to a lesser degree, red clover. Severely infected plants of alfalfa often developed a brown-black internal necrosis of the taproots.

A Verticillium-like fungus was isolated from alfalfa plants with upright, wilted stems and from dying plants in a field nursery. Although the conidia and conidiophores were typical of Verticillium alboatrum, no dark mycelium or microsclerotia developed in culture. Some black bodies were observed in diseased stems. In greenhouse inoculations the fungus was not pathogenic to alfalfa.

Selecting for Leafhopper Resistance

Studies of several alfalfas from potato leafhopper resistant nurseries at the Pasture Research Laboratory and at Beltsville, Maryland showed that yellowing, dwarfing, and antibiosis were independent expressions of injury, and that each should be taken into account in selecting for leafhopper resistance. Procedures for appraising dwarfing and antibiosis are being investigated.

Red Clover

Increasing the Longevity of Red Clover Stands by Controlling Root Weevils and Fusarium Root Rot

To determine the effects of pesticides on persistence of red clover, field plots with the following treatments were established in 1960: Frequent applications of fungicides (F), insecticides (I), pesticides (IF) and a check (Ck). At the end of the third growing season (1962) no differences were evident between plants in F and Ck plots, and those of I and IF were similar.

Differences between the insecticide treated plots and non-insecticide treated plots were: Root diameters 15 mm and 12 mm; ground cover 45% and 1%; percent of plants showing Sitona spp. and/or Calomycterus setarius chewing 19 and 88 percent; borer damage 1 and 52 percent; virus 15 and 50 percent; root rot moderate compared with severe; tap root rotted off 10 and 75 percent; internal breakdown (IB) 70 and 65 percent.

The plots will be examined for density records in the spring of 1963 and the experiment terminated.

Larval Injury by Calomycterus setarius on Roots of Red Clover
and Its Relationship to Incidence of Fusarium Root Rot

Results of greenhouse experiments conducted in 1960, '61, and '62 showed for the first time that Calomycterus setarius larvae fed on small rootlets of red clover and when full grown, gouged the tap and lateral roots. The crown and root weights of weevil-damaged plants were less than those in the controls. Of four treatments---control, soil infested with C. setarius, with Fusarium roseum and F. oxysporum, and with both C. setarius and F. spp.-- most rot developed on plants in the last treatment.

Internal Breakdown (IB) of Red Clover

Work was continued to determine the cause of or factors affecting the incidence of IB of red clover. In genetical studies 6 crosses were made between F₃ plants which had no IB after 6-8 months, and F₁ plants that had IB. Also included in the study were 2 P.I.'s from Iran. From test rows at Geneva only one plant from two different seed sources from Iran did not develop IB. Dr. S. W. Braverman supplied these two plants. They were crossed and the F₁ plants examined for IB. The incidence of IB in the progenies as well as in unselected Pennscott plants is presented in Table 1. For comparisons, similar data for 1959, 1960, and 1961 are included.

The incidence of IB in plants from IB X IB crosses was 100%. The F₄ plants from the non-IB X non-IB crosses had no less than the F₃ parents but were lower than unselected Pennscott. The F₁ Iran plants were vigorous and had a low (30%) incidence of IB. Stems and petioles of plants varied from glabrous to pubescent.

Table 1. Reaction of Pennscott crosses (parents with and without IB), unselected Pennscott, and an Iran introduction to IB. Plants 6-8 months old.

% Internal breakdown (IB)					
IB X IB	Pennscott		Range of crosses	Pennscott Unse- lected	Iran P.I. Non-IB X non-IB
	Non-IB X non-IB				
1959	40 (F ₁)	16 (F ₁)	--	60	--
1960	98- 100 (F ₂)	70 (F ₂)	40-100	65	--
1961	--	22 (F ₃)	17- 53	54	--
1962	100 (F ₂)	38 (F ₄)	29- 80	72	30 (F ₁)

IB development in tiller-plants--Four to six tiller-branches were broken off from plants with and without IB and rooted in 4-inch pots. The plants were examined 6 months later. Sixty percent of the tiller-plants from IB plants had developed IB while only 9% of the tiller-plants from non-IB plants had IB. Not all the tiller-plants developed typical crowns, the area where IB occurs.

IB in strawberry clover--Approximately 100 plants of strawberry clover were examined for IB. After 8 months no typical IB was observed in the crown tissue. The taproots and crowns of strawberry clover are small, somewhat like ladino white clover. The stolons rooted down.

Anatomical study of IB--F₂ seedlings selected to develop IB within 4 months and F₄ plants selected for a low incidence of IB were sectioned. Crowns of both groups of plants were embedded and sectioned at 2-week intervals when plants were one month old. No significant observations were made.

Selection for Persistence in Red Clover

Two nurseries were established in 1961 using polycross seed harvested in 1960 from selected, cloned plants.

In 1962, plants in the plots were observed for vigor, ground cover, and powdery mildew. As one would expect differences were evident. Since persistence is the main objective, detailed notes will be taken next spring.

Lines which persist well may be useful to breeders in the region.

Orchardgrass

Breeding Improved Dactylis glomerata

Progress of 1962 field trials was hampered by the most severe drought from May to September in the history of the Laboratory.

Two nurseries were seeded in April for polycross progeny testing. One consisted of broadcast seeded plots in cooperation with the Department of Agronomy at The Pennsylvania State University. The other was planted in 20 feet long drilled rows with an estimated 25 germinable seeds per linear foot. Both plantings failed to become established; sufficient seed is available to repeat the planting of the 2 tests in 1963. The parent clones were also selfed in the field in 1962 but most clones gave no or only occasional seed. One polycross nursery with 30 clones was planted for seed harvest in 1964.

Orchardgrass with Male-sterility

Crosses were made in the greenhouse in 1961-62 between 8 heterozygous male-fertile and 8 normal, unrelated clones used as seed parents. Hybrids were established in the greenhouse in 1962-63 for sibbing and selfing. If male-sterile progenies from sibbing are obtained they will have resulted from genic rather than cytoplasmic male-sterility factors.

Nonheading Orchardgrass

Nonheading orchardgrass may be valuable forage if such strains will flower in the seed producing areas. Comparisons made between heading and non-heading sibs regarding cellulose, lignin and protein content showed the nonheading plants to be superior in quality but generally less vigorous than the flowering sib plants (1960 Annual Report, p. 20).

A study was made in 1961 on treatments which might induce flowering in 22 clones selected over 2 years for nonheading habit in the field.

The treatments were as follows:

A: outdoors, field

B: September 20 to April 1, 70°F, natural daylength in greenhouse

C: October 20 to December 1, 50°F, natural day

December 1 to April 1, 70°F, interrupted night by 2 cycles of

1 hour supplemental light (10 pm to 11 pm, 3 am to 4 am)

D: October 20 to January 1, 50°F, natural day as above

January 1 to April 1, 70°F, interrupted night as above

E: October 20 to February 1, 50°F, natural day as above

February 1 to April 1, 70°F, interrupted night as above

Seven of the 22 clones flowered sporadically outdoors the following spring, treatment A. Two heads were noted in one replicate of one clone treatment B; none of the other clones flowered. The length of the cold treatment in C was insufficient to induce flowering in 17 clones. Twelve clones flowered after treatments D and E.

On the basis of flowering response of all 22 clones and considering all 5 treatments, 12 clones were selected to become parents of three 4-clone synthetics. Clones 61-1, 61-2, 61-13, and 61-17 were included in synthetic A. They flowered in the field in 1962. Clones 61-11, 61-14, 61-19, and 61-20 flowered less than those in synthetic A and were included in synthetic

B. Synthetic C was made up of clones 61-4, 61-12, 61-15, and 61-18. These clones failed to flower after any of the treatments, including treatment A.

Clones of each synthetic were increased in the greenhouse and the material was shipped to Clarence M. Rincker, Prosser, Washington, who will supervise the seed increase blocks of these synthetics. It is hoped that these synthetics will provide material which can be used to compare nonheading orchardgrass with normal flowering orchardgrass in the Northeast from the standpoint of forage quality and production.

Selection for Fertility in Derivatives of Intergeneric Hybrids

There is no known breeding approach which will insure that selections with improved seed fertility among intergeneric hybrid derivatives will maintain the contribution by Lolium species to improved forage production of Festuca arundinacea. Selection among the most fertile progenies in each generation may restore the fertility level of raw polyploids but, through intragenomic pairing of chromosomes, the combination sought may not materialize. Ultimately, the clones to be combined for the purpose of variety synthesis must possess genes for adequate seed production and for high forage production.

The 42-chromosome breeding material has been of low fertility as measured by percentage of stainable pollen. Therefore, close attention will be paid to improvement of fertility through progeny testing.

The severe winter of 1961-62 killed 90.0% of Lolium-Festuca derivatives of $2n = 21$ and $2n = 28$ breeding materials with potential seed fertility. Surviving $2n = 28$ plants which had been treated with colchicine or ethylene-disulfate will be used in further tests for improved fertility and winter-hardiness. Potential fertility of Lolium-Festuca hybrids has been estimated by various characteristics. No correlation existed between number of micronuclei and per cent well-stained pollen of 22 selected 42-chromosome clones. Per cent well-stained pollen of 104 clones in the greenhouse was correlated with similar data from the field, $r = 0.58^{**}$.

A mean of 20% variation in well-stained pollen was noted for 2 sampling dates in the field.

Variable seed yields of 2 Lolium-Festuca polycrosses were harvested. To evaluate visual ratings for low and high agronomic desirability of clones in these polycrosses, single crosses of low X low, low X high, and high X high together with open-pollination progenies were established.

Cytogenetics of Kentucky Lolium-Festuca

Results of studies in cooperation with R. C. Buckner, Lexington, Kentucky were published in 1962.

It was concluded that $2n = 42$ chromosome plants occurred most frequently in the backcrosses of the intergeneric hybrids (annual ryegrass X tall fescue, perennial ryegrass X tall fescue) to annual ryegrass and to tall fescue. Unusual reduction divisions were postulated to account for the origin of $2n = 35$ and $2n = 42$ chromosome plants from backcrosses to annual ryegrass and $2n = 42$ chromosome plants among progenies of $2n = 56$ amphiploids. There was little meiotic regularity and fertility as measured by stainable pollen. A group of six $2n = 42$ chromosome plants among progenies of a $2n = 56$ amphiploid, however, showed low percentage of meiotic regularity and higher than average pollen stainability. More fertile plants appeared in somewhat larger numbers in advanced backcross generations than in early ones. Plants with at least 20% completely stained pollen were considered fertile and were found among backcrosses ($2n = 42$) involving tall fescue with either or both annual and perennial ryegrass, and among progenies ($2n = 42$ and $2n = 56$) from colchicine-treated hybrids of annual ryegrass and tall fescue. No significant differences in stainable pollen were found in backcrosses of annual and perennial ryegrass hybrids to tall fescue. Among a small number of clones for which data were available, seed production and stainable pollen varied independently. Further co-operative work included determination of chromosome numbers for 116 plants. Clones fertilized with a complete nutrient solution produced roots with number of dividing cells approximately equal to those that were grown in soil without added nutrients.

Bromegrass

Selection with Leaf Disease Resistance

At present no commercial brome cultivars used in the Northeast region have sufficient resistance to Helminthosporium bromi and Stagonospora bromi. In 1962 seed from 18 resistant clones was obtained. The variable seed quality was sufficiently good for 15 clones to warrant a 1962/63 greenhouse test for progeny evaluation of resistance to the 2 leaf diseases, with artificial inoculation techniques.

The degree of resistance shown by these progenies will determine the type of field planting of the polycross progenies. If exceptionally high levels of resistance are found in some progenies, parent clones with good vigor ratings will be combined into synthetics. Seed of this material is expected in 1963-64. Broadcast plantings may be made in 1964 to study forage quality, possibly by protein analysis, and persistence.

Evaluation of Effects of Two Temperatures on Micronuclei
per Quartet in Bromus inermis Leyss

The objective of this study was to ascertain effects of 2 different temperatures (50° F and 70° F) previous to heading on fertility as measured by the occurrence of micronuclei in quartets. Twenty-four clones were divided into 12 low and 12 high seed-producing clones. These were grown at 70° F in the greenhouse. Three pots of each were kept at 70° F and 3 were moved to a section at 50°. Data obtained showed no significant correlations between the meiotic characters and temperatures. Clonal differences in micronuclei per quartet within each of the low-fertility and high-fertility groups were greater than differences between the groups. A manuscript on these studies has been accepted for publication.

Ryegrass

Interspecific Hybridization

For purpose of interspecific hybridization, 7 Lolium species were induced to flower in the greenhouse by combinations of low temperature followed by interrupted dark treatments. Lolium strictum was the earliest to flower; L. remotum was slightly later than L. temulentum. There was no interaction between temperature and species.

Seed was obtained in 8 crosses between self-incompatible (S.I.) and self-compatible (S.C.) species, represented by the S.I. species L. multiflorum, L. perenne, and L. rigidum and the S.C. species L. loliaceum, L. remotum, L. strictum, and L. temulentum. Hybrids were detected by percentage of stainable pollen and by chromosome behavior in meiosis. Paper chromatography of plant sap needed further refinements to serve as a tool to distinguish the hybrids from the parent species.

Meiosis was normal in the parent species but extra chromosomes were observed in many F₁ hybrids. The extra chromosomes may have resulted from fragmentation or misdivision of univalents. Analysis of chromosome pairing in hybrid meiosis indicated that, in general, the genome of one species was quite homologous to that of the other species. The taxonomic identification of accessions used will be made by Dr. Edward E. Terrell of The New Crops Research Branch.

Tall Fescue

Meiosis and Genome Homologies in Tall Fescue

Increased meiotic irregularity attributed to reduced homeostasis in the inbred population was found in a population of 79 first-generation inbreds. Segregation of recessives deleterious to normal meiosis and perhaps increased pairing of homeologous chromosomes in this hexaploid species may also have been involved. A highly significant correlation of +0.37 was found for per cent of AI cells with bridges and/or fragments vs. per cent of quartets with micronuclei. No significant relation existed between either of these cytological irregularities and self-fertility.

A paper on these studies was published in 1962.

BIOCHEMISTRY, PHYSIOLOGY AND SOILS

Carbohydrate Studies on Grasses

The carbohydrate studies are directed to the hemicelluloses and to their relation to the feeding value of the forage. Hemicelluloses were partially extracted from the forage by acid, the action of which resulted in solubilization and hydrolysis, the two processes taking place simultaneously but at different rates, depending on the conditions of treatment. Hydrolysis was greater with HCl and HNO₃, less with H₂SO₄, and still less with H₃PO₄. For short periods of treatment the amount solubilized was always much greater than the amount hydrolyzed. Under comparable conditions the proportion of the total hemicellulose which was solubilized or hydrolyzed was less in forages of greater maturity, with greater lignification, and of less digestibility. When a standard procedure that has been tentatively adopted was used the degree of solubility was positively correlated with the digestion coefficient of dry matter in 18 forages of different types, $r = +0.63^{**}$. In 16 other forages, mostly grasses, the amount hydrolyzed was not significantly related to digestibility, $r = +0.29$, nor was the amount solubilized, $r = +0.42$, but if the population was limited to the 13 grasses of this group, the values were, resp., $r = +0.32$ and $r = +0.74^{***}$. Solubility rather than hydrolysis of hemicelluloses appears to be the best criterion of quality, at least in grasses.

Measurement of the Feeding Value of Forages
by Chemical Analysis

The objective of these studies is to determine how closely digestion coefficients may be predicted from the chemical composition of forages. A number of "fiber" methods were investigated and some were more satisfactory than crude fiber for some types of forage but none proved suitable for all types. Of particular interest was a scheme used in some state evaluation programs. The forages are analyzed for crude protein (CP) and crude fiber (CF) and from these are calculated total digestible nutrients (TDN) by the equation:

$$\text{TDN} = 89.55 + 0.372 \times (\% \text{CP}) - 1.1 \times (\% \text{CF})$$

Calculations were made by us on 50 samples on which all such data were available and the results are given in Table 1. The calculated TDN values were lower than the TDN values determined conventionally in grasses and were higher with legumes. Particularly striking are the high standard errors, over 10 percent of the TDN values. It was also investigated whether analyses, for both crude protein and crude fiber, were necessary. Using the same 50 samples and basing a regression on the relation between TDN and crude protein and another between TDN and crude fiber, we obtained smaller standard errors for the 50 samples, 4.8 and 4.6, resp. These indicate that either crude protein alone or crude fiber alone will give a closer estimate of TDN than will the above formula which uses both.

Table 1. Comparison of true TDN obtained by the conventional method and that obtained by calculation from crude protein and crude fiber contents.

Population	True TDN Ave.	Calcd. TDN Ave.	Difference Range	S.E.
40 grasses	64.4	60.6	-14 to + 6	6.4
7 alfalfa	61.6	65.6	- 3 to +11	7.6
1 Ladino clover	70.5	77.4		-
50 total	64.3	61.7		6.8

Climate at State College

Temperatures were near normal during the growing season except in May which was 5 degrees above normal. Temperatures in January, February, September, November and December were 4, 2, 4, 3, and 7 degrees respectively below normal. Snow cover was from 1 to 17 inches.

The outstanding deviation from normal climate was lack of precipitation from mid-April until late September. April precipitation was 3.16 inches below normal and for July it was 3.01 inches below normal. This was less than had been previously observed at this location in 78 years. Hay production on farms was low, pastures and lawns became brown, corn made such limited growth that it was cut as forage for cattle feed. Precipitation during September initiated growth of grasses but not until late October was soil moisture replenished.

Percent available moisture at 4 - and 8-inch depths beneath a clipped blue-grass sod ranged from 90% in early April to 10 and 15% respectively in May. During June, July, August and most of September less than 10% available moisture was measured at depths of 16 inches.

Soil temperatures during June, July and August at the 4-inch depth beneath a lawn sod ranged between 71-75° which was 2 or 3° above normal, partially resulting from soil drier than usual.

Daily solar energy, recorded since 1941 by The Pennsylvania State University Meteorology Department was summarized on a monthly basis by the Agronomy Department. This summary indicates that sunshine in May 1962 was greater than any recorded for this month and that solar energy in the months of June, July and August had been exceeded in these months only 4, 3, and 3 times respectively during the past 21 years.

The last freezing temperature of 28°F in the spring occurred April 16, and the first in the fall on October 26. Period between freezes was 192 days.

Northeast Regional Climate Cooperative with 10 States

Daily measurements of precipitation, air and soil temperatures, humidity, dew, cloud cover, wind and other meteorological factors were made at Orono, Maine; Northwood, N. H.; Burlington, Vt.; Storrs, Conn.; State College, Pa.; Morgantown, W. Va.; New Brunswick, N. J.; and College Park, Md. These observations were sent to the Pasture Laboratory for summarization on a bi-weekly basis and summaries were mailed to each station monthly.

During 1962 precipitation was below normal at most stations January through August and was particularly low in May through August, and also through September in Conn., R. I. and Maryland. Above normal precipitation during September was insufficient in Pennsylvania and New York to replace soil moisture 16 inches deep.

Air temperatures ranged 1 to 7° below normal during the winter months and most of the growing season. An extreme of 7° above normal occurred in May in Maryland, Pennsylvania and New York.

Monthly averages of soil temperatures 4 inches deep in a grass sod ranged between a low of 26° during February in Vermont and a high of 81° F during June in Maryland. Snow and cooler weather in December and January decreased temperature differences between locations.

Cloudiness varied greatly between months as well as between locations. The greatest range of cloud cover occurred at Ithaca, N. Y. which was least cloudy in May and most cloudy during November and December.

The windiest month was March in Rhode Island with a monthly average wind speed of 194 miles per day. Maryland was least windy and especially during June and July when average wind speeds were 36 miles per day.

Growing periods for forage between first and last freezes at temperatures of 28°F ranged from 130 days in Maine to 203 days in New Jersey.

Legume and Grass Seedling Establishment

Field trials of seedling emergence with alfalfa, ladino white clover, orchardgrass and brome grass following different dates of seeding in rows were continued. Triplicate plots of each species were seeded April 25, May 17, and June 15 at 1/2 inch depths in prepared soil. Germination and emergence were entirely dependent on natural precipitation, which was extremely low during these months. Because only scattered showers occurred which were followed by rapid drying conditions, those species with seeds that made growth soonest provided the best stands. Legume seedlings showed greater extension of root and stem parts sooner than grasses. Alfalfa emerged faster (2-3 days) than white clover (3-5 days). Brome grass was faster (3-4 days) than orchardgrass (5-8 days).

Examinations of seedlings in relation to occurrences of rain and higher temperatures indicate that alfalfa seedlings grow most rapidly and were better able to emerge through crusted soil, or had been able to emerge before a hard crust had completely formed. White clover which grew more slowly had less emergence but both legumes were far superior to the grasses. These studies during a year when total precipitation and frequency were limited indicate the importance of species' capability for rapid growth when moisture becomes available.

Growth of Orchardgrass Affected by Initial
Reserves, Cutting Height and Recovery
under Two Light Intensities

This is a continuation of studies on growth and reserves as they are affected by environments and management. Seedlings of orchardgrass were grown in 4-inch pots in the greenhouse with and without shade treatments to provide low- and high-reserve plants. Groups of these were harvested at differential heights (1-1/4 and 2-1/2 inches) and left to recover under two light conditions (natural and 2/3 natural under shade).

An initial cutting at both heights was followed by two 3-week recovery periods under the two light conditions. Dry weights of top growth produced under each treatment and biological measures of reserves in these plants were obtained. Similar samples were taken for chemical analyses.

Plants with high reserves initially yielded the same or more than low-reserve plants given the same treatments during their recoveries after cutting. The various treatments, however, were primary factors affecting subsequent yields and not the higher reserves present initially.

Of the treatments used, light intensity and height-of-cut had greatest affect on the resulting growth. Plants with high reserves initially cut at 1-1/4 inch height produced 55% more dry matter under full natural light than under 2/3 light. Similar low-reserve plants cut at the 2-1/2 inch height yielded 34% more than when cut at 1-1/4 inches.

Biological measures of reserves indicate that dark-growth per tiller was greater initially from high-reserve plants and that the reserves remained higher when plants were cut higher. Irrespective of height of cut, more reserves accumulated in plants that received the higher light intensity.

Rates of growth obtained from leaf area measurements taken during recoveries of both high- and low-reserve plants indicate that growth rates were slightly faster on low-reserve plants. Rates of growth under two light intensities and also following cutting at two heights indicate a more rapid extension of leaf area under low light and also following low cutting, irrespective of reserves initially present. Plants which extended leaves more rapidly were frequently not higher yielding. Further work is needed to explain the nature of factors affecting growth rates and their relationships to total growth produced.

Physiological Studies on Creeping-rooted Alfalfa

Work was continued on effects of periods of short days on the formation of adventitious stem sites. In 1961 three clones were found to be short-day sensitive and two were relatively insensitive.

Rooted cuttings of the short-day sensitive clone were started and grown in the greenhouse under long days and then given short days when two or three months of age. Short days increased site formation on the two-month-old plants but not on those three months of age when the treatment with short days began.

Effects of natural daylengths in autumn and spring on field plots were studied with three clones. Site formation after two months' growth was greater on cuttings planted in the fall than on the same clones planted in the spring. These results agree with greenhouse studies and suggest that for practical application fall plantings would express the creeping habit more rapidly than spring plantings.

Short days consistently increased site formation with the expected differential clonal responses. The reaction responsible for the short-day stimulation seems to be related to the stage of plant development.

Establishment of Ladino Clover in Orchardgrass Sods

Effect of soil moisture level--An experiment was conducted in greenhouse culture to evaluate the influence of full competition, below- and above-ground competition, no competition except for air, and no competition (monoculture) treatments at four moisture levels on the ability of ladino clover seedlings to become established in orchardgrass sods fertilized with nitrogen. The moisture treatments were irrigation to near field capacity when soil moisture tension approached 15 atm. (low), 2 atm. (med.), 1 atm. (high) and continuous irrigation from a tensiometer 50 cm above a free water surface. Soil fertility levels were high and, based on visual diagnosis, and plant tissue analyses for eleven mineral nutrients, mineral nutrients were considered non-limiting.

The results indicate quite clearly that ladino clover seedlings can be readily established in nitrogen fertilized orchardgrass sods when favorable conditions of light, moisture, and nutrients are maintained. Fair establishment occurred under full competition treatments providing that a very high soil moisture and nutrient level were maintained. In spite of the good establishment the growth of ladino clover seedlings under conditions of full root competition and no aboveground competition at very high soil moisture was approximately one-half that of plants growing under similar conditions in monoculture. Since growth depression of seedlings was observed early, it was felt that this growth depression was not due to nutrients, but was probably caused by soil moisture stress. The possibility of orchardgrass sods releasing allelopathic factors inhibitory to the ladino clover seedlings will be reported in a subsequent section.

Allelopathy in orchardgrass sods--A greenhouse experiment was conducted to evaluate the possibility of release of substances by orchardgrass roots which could inhibit the growth and development of ladino clover seedlings. The treatments used included full root competition with no aboveground competition at a very high nutrient level, root segregation by non-porous, and porous ceramic walls and controls in uncropped soil. All treatments were kept at a high soil moisture level. The results over a 10-week establishment period showed no evidence for orchardgrass roots releasing a mobile substance which was inhibitory to the growth and development of ladino clover seedlings. A response to the nutrient solution under full root competition was attributed to increased potassium level in the plants. This observation was supported by plant tissue analyses. With the exception of the lowest fertility treatment and porous wall-uncropped soil there was no evidence that mineral nutrition was limiting the growth and development of the ladino clover seedlings.

Orchardgrass leaves from plants deficient in nitrogen, rich in nitrogen, and senescent leaves were mixed with river sand in varying proportions to evaluate the possibility of products being released which were inhibitory to the growth of ladino clover seedlings. Dead orchardgrass leaves mixed with sand depressed the germination and growth at all concentrations used over that in sand alone, whereas 3% nitrogen rich orchardgrass leaves added to sand depressed germination and growth of ladino clover seedlings. Ladino clover seedlings growing where nitrogen-deficient leaves were added (1.5 and 3.0%) were as good or better than those growing in river sand. The nature of the growth inhibition was primarily stunting of the entire plant. Further studies are necessary to evaluate the significance of these findings.

Specificity of competition--A study was conducted to evaluate the effect of competition from orchardgrass on the establishment of four species having variable soil aeration requirements. These species were the following: rice, variety Arkrose; wheat, variety Pennoll; birdsfoot trefoil, variety Viking; and ladino clover, variety Pilgrim. The study was based on the assumption that all other factors such as mineral nutrient supply, soil moisture, and sunlight would be optimum or in slight excess, so that growth suppression of wheat and ladino clover would be greater relative to rice and birdsfoot trefoil if a soil aeration condition was involved in the observed growth suppression of ladino clover seedlings by orchardgrass sods. It was found that the assumed conditions were not obtained for rice and ladino clover. The rice was severely nitrogen deficient whereas the orchardgrass and wheat were not deficient in nitrogen. Damping off injury (assumed) severely affected the growth of all ladino clover seedlings, but apparently had very little effect on birdsfoot trefoil. The growth of wheat and birdsfoot trefoil was as good in full competition with frequently clipped orchardgrass as in monoculture. There was no evidence for allelopathic effects of orchardgrass on any of the species since they apparently grew as well in full root competition with severely clipped orchardgrass as in monoculture except for rice where competition for nitrogen prohibited its use as an indicator of soil aeration conditions.

Alfalfa in Association with Quackgrass

A small study using full root competition, porous wall root segregation, and non-porous wall root segregation treatments between alfalfa seedlings and quackgrass plants indicated that no substances moved through an inert porous wall which were capable of inhibiting the growth of the alfalfa seedlings. The great inhibition of growth of the alfalfa seedling in full root competition with quackgrass under conditions of high soil moisture and fertility suggests that distance between plant roots may be an important factor. Studies should be conducted evaluating the effect of distance of root separation between competing species.

Phosphorus Fertilization of Forage Grasses and Legumes

Effect of phosphorus withdrawal on the growth curve of ladino clover seedlings--Ladino clover seedlings were grown in solution culture with phosphorus withdrawn from the nutrient solution at progressive stages of seedling development. Due to a limited supply of distilled water, two replicates of phosphorus withdrawal treatments actually resulted in reduction of P content of the solution from 0.3 and 1.1 to 0.1 instead of complete phosphorus withdrawal. The third replicate consisted of essentially complete phosphorus withdrawal.

The results indicate that true phosphorus withdrawal influenced rate of growth at all stages of plant growth tested. However, when phosphorus withdrawal at later stages of plant development consisted of a reduction from 1.1 to 0.1 ppm P, plant growth was unaffected. Early partial withdrawal did influence the rate of growth of the seedlings. The conclusion to be drawn is that the increase in root growth, accumulation of "mobile" plant tissue phosphorus, and possibly enhanced ability to obtain phosphorus from dilute solutions were responsible for the fact that a ten-fold reduction in solution phosphorus concentration at later growth stages had no detrimental effect on plant growth. The best growth of ladino clover seedlings was obtained on a solution containing 0.3 ppm P.

Plant tissue analyses for phosphorus content should give valuable information on the levels of phosphorus required in ladino clover seedling tissues for optimum growth at progressive stages of development.

Response of grasses and legumes to phosphorus fertilization when other nutrients are not limiting--Three experiments were conducted in greenhouse pot culture to evaluate the absolute and relative responses of tall fescue, timothy, and ladino clover to phosphorus fertilization. In the second experiment, the response of these same forage species to phosphorus fertilization on three soil types was evaluated. The overriding objective of these experiments was to be sure that mineral nutrients other than phosphorus were not limiting the growth of any of the species. The soil types used in this investigation were the Hagerstown silty clay loam (Centre County, Pa.), Morrison silty clay loam (second experiment) and Morrison loam (first and second experiment) (Centre County, Pa.), and Red Bay

fine sandy loam (Florida). Rates of phosphorus fertilization varied from none to 640 pp2m P. Nitrogen and potassium levels were varied in the first experiment (Experiment A).

The results of the three experiments indicate the following:

Ladino clover responded more to phosphorus fertilization than did either timothy or tall fescue in the first experiment (in terms of both absolute and relative increase in growth due to phosphorus fertilization). All species gave similar relative responses to phosphorus fertilization in the second experiment except on the Hagerstown soil where the grasses responded relatively more to phosphorus fertilization than did the ladino clover. The results of Experiment C tended to confirm those of Experiment A.

The response of tall fescue and timothy to phosphorus fertilization was very slight at low N levels (100 pp2m), but the increase due to the highest phosphorus treatment was almost twice at the high nitrogen levels (700 pp2m), thus illustrating the importance of adequate nitrogen fertilization in evaluating the phosphorus response curve of grasses. Plant tissue analyses for nitrogen indicate that even at the highest nitrogen level with high phosphorus, the growth of the grasses was limited by nitrogen deficiency. The placement of phosphorus in the surface 2 inches of soil was of more benefit to ladino clover than to either of the grasses. This effect may have been masked by nitrogen deficiency in the grasses.

Ladino clover roots were not nodulated when growing in soils not receiving phosphorus fertilizer with the exception of the Hagerstown soil in Experiment B.

The Red Bay fine sandy loam soil gave the best growth of all forage species at the high phosphorus level in Experiment B.

Plant tissue analyses for phosphorus indicated that the poor growth of grasses and legumes in Experiment B, and the poor growth of ladino clover in Experiment A were due to phosphorus deficiency. Analyses for Al and Mn in plant tops indicated that these elements were not present in toxic quantities.

Final interpretations and conclusions will not be formulated until plant tissue analyses are completed.

Ability of ferric phosphate to supply phosphorus to red clover growing in an acid, phosphorus deficient soil--Ferric phosphate at 1000 pp2m P on an acid Morrison soil was as effective a phosphorus source for red clover as mono-calcium phosphate at 2000 pp2m P. Ferric phosphate at 2000 pp2m P resulted in depressed growth of red clover compared to that of 1000 pp2m P, but not compared to that of the control without phosphorus fertilization.

Iron Availability to Orchardgrass in Nutrient Culture

Some qualitative observations on growth of orchardgrass in nutrient solution indicate that supplemental aeration of the nutrient solution was not helpful in the case of orchardgrass and may have decreased iron availability. This effect appears to be enhanced by increased levels of nutrients in the solution bathing the roots. The qualitative observations reported herein are supported by recent published data (Vose, P. B. 1962. *Annals of Bot.* 26 (103): 425-437).

Effect of Defoliation on Root Growth in Orchardgrass

Several exploratory studies were conducted with orchardgrass plants to determine if clipping the plant severely caused existing adventitious root growth to cease within a short time after clipping. No evidence for orchardgrass root growth stoppage after severe clipping was found. In some cases, reduced extension of individual roots was found, and in other cases increased extension of individual roots was observed. This apparent contradiction in results may be explainable on the basis of increased number of new roots initiated (where root extension slowed down), and decreased number of new roots (where root extension did not slow down). Thus the effect of defoliation on root growth is considered to be operative through the effects of defoliation on plant metabolism, tiller growth, and tiller primordia development. These exploratory experiments are considered only as a base from which continuing studies on root growth in grasses and legumes will be developed.

RESEARCH AT BELTSVILLE, MARYLAND

Title: EFFECTS OF PHOSFON ON GROWTH OF ALFALFA

Leaders: B. L. Norwood, P. C. Marth, and C. H. Hanson

In alfalfa breeding programs, plants are frequently transferred from the field to the greenhouse during the fall and placed under artificially induced long days for crossing. Under those conditions, alfalfa generally attains a height of 4 feet or even more. Staking or caging is usually required to prevent stems of adjacent plants from becoming intertwined. Expenditures for labor and materials would be greatly reduced if plant regulators of the growth-retardant type could be used to control plant height.

Four alfalfa clones were treated with phosfon at rates of 0, 50, 100, 150, 200, and 250 mg. per pound of soil. Plant height of transplanted alfalfa was reduced by about 38 percent when a solution of phosfon was applied to the potting soil at the rate of 200 or 250 mg. per pound of soil. The number of stems and the number of racemes per plant were reduced 60 and 49 percent, respectively. The interaction of clones x phosfon levels was significant for number of stems and foliage color; otherwise, the divergent clones studied reacted similarly to the phosfon treatments. Effects of phosfon on seed set and seedling vigor of S_1 and F_1 progenies were not established.

Phosfon appeared satisfactory for reducing height of some alfalfa clones in the greenhouse. However, the reduction in height of taller types did not appear great enough to eliminate the use of supporting canes or cages to prevent lodging. The unfavorable effect of phosfon in reducing the number of racemes per plant further limits the usefulness of this compound in alfalfa breeding work.

Title: INSECTICIDAL CONTROL OF THE ALFALFA WEEVIL

Leader: C. C. Blickenstaff

Of materials applied in the fall of 1961 for control of alfalfa weevil larvae during the spring of 1962, Telodrin at 0.75 lbs. per A. gave excellent control. Other materials that gave between 82 and 88% control and their rate of application were Methoxychlor, 3 lbs.; EPN, 2 lbs.; and Dri-Die 91, 4 lbs. Spring applications showed that the surfactant Igepal CO 630 added to Dimethoate increased its effectiveness significantly, that Telodrin at 0.125 lb. is very effective, and that several experimentals give good control. A comparison of the effect of gallonage and pressure on control showed increasing control with increasing gallonage (12.5, 25 & 50) and decreasing pressure (150, 80, & 40 psi). In the laboratory, 26 candidate insecticides were screened against weevil adults and larvae. This work is in cooperation with the University of Maryland.

Title: BIOLOGICAL CONTROL AND ECOLOGY OF THE ALFALFA WEEVIL

Leader: C. C. Blickenstaff

The alfalfa weevil parasite release program, started in 1961, was expanded in 1962 to include releases in Georgia, Tennessee, Ohio, and Massachusetts. Approximately 19,000 adults of Bathyplectes curculionis (Thoms.) were released at 13 locations in seven states. This parasite was recovered from 10 of 11 1961 release sites sampled, showing widespread initial establishment in the east. Feeding tests were conducted with larval and adult weevils in which 47 different plants were offered. Both larvae and adults fed on nearly all of the true clovers (Trifolium spp.), and exceptionally well on yellow and white sweet clovers (Melilotus). Artificial diet work continued, using alfalfa meal as a base, but with little success. Four complete generations of weevils were reared during the year. Rearing parent generation larvae under short daylengths (8 hrs.) resulted in non-diapausing adults. Subsequent generations were non-diapausing regardless of daylength conditions and the time required for sexual maturation became less with each generation. Reciprocal crosses between weevils from 4 western locations and eastern weevils substantiated results obtained in 1961. Western males X eastern females produced infertile eggs, while reciprocal crosses produced fertile eggs. The sex ratio of progeny was 8.5 females per male as compared to the normal 1:1.

Title: PLANT RESISTANCE TO THE ALFALFA WEEVIL

Leader: C. C. Blickenstaff

In cooperation with Alfalfa Investigations, CRD, plant resistance studies were started in 1960. Field ratings for larval damage in 1961 and 1962 on nursery entries were highly correlated. One hundred five entries selected from the field to represent the range of damage observed in the field, were tested in the laboratory and greenhouse for larval survival and damage, and egg laying preference. Twenty-five of these were also tested for larval weight and adult feeding preference. Highly significant correlations were obtained between field damage and laboratory egg laying, between field damage and stem diameter, and between egg laying and stem diameter. Several varieties reported or determined as resistant to other insects, and a number of plant introductions have been characterized in the laboratory for egg laying, stem diameter and adult feeding. Several promising sources of resistance have thus been identified. Tests are in progress to further characterize and study the original 105 selections in the field in terms of growth characteristics and weevil infestation. Also in progress are tests to determine the heritability of resistance as expressed by egg laying preference.

REPORTS OF R. AND M. COOPERATIVE RESEARCH

Title: PROJECT NE-9 - THE INTRODUCTION, TESTING, MULTIPLICATION AND PRESERVATION OF POTENTIALLY VALUABLE PLANTS FOR CROP IMPROVEMENT AND INDUSTRIAL USE.

Leader: F. C. Stark, Chairman, Regional Technical Committee

Cooperators: Conn. (Storrs), Conn. (New Haven), Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York (Cornell), New York (Geneva), N.C.R.B., C.B.S.I., C.S.E.S.S., SCS, ARS, USDA

The plantings at Geneva in 1962 included 781 forage legumes and grasses. Among the forage introductions grown in 1962 were 288 forage legumes and grasses carried over from the 1961 planting and now in their second growing season. All introductions successfully increased are being catalogued and will be made available to plant breeders.

Descriptive and evaluation notes were recorded on all introductions grown and this information will be included in the catalogue. With the cooperation of the Regional Representatives, NE-9, information has been assembled on the merits and performance of plant introductions at the Experiment Stations of the Northeast Region. A summary of performance information under the title "Promising Introductions of 1962" was prepared.

The officers for the Committee elected for 1963 are: Chairman, F. C. Stark, Secretary, D. D. Dolan, Executive Committee, E. P. Brasher.

The Chairman of the Sub-committee for forage legumes and grasses is L. A. Mitterling, Storrs, Conn.

Two timothy selections which have continuously shown superior rust resistance in field and greenhouse testing at Geneva, N.Y., have been assigned P.I. numbers 285539 and 285540.

The testing of red clover introductions for resistance to red clover vein mosaic, yellow bean mosaic, and powdery mildew will be continued by carrying on selections made during the 1962 season.

A program to test all available alfalfa introductions for resistance to black stem (Ascochyta imperfecta Pk) will be commenced.

Title: PROJECT NE-13 - STUDIES OF THE PHYSICAL PROPERTIES, BEHAVIOR, AND FORMS OF FORAGE AS RELATED TO ENGINEERING APPLICATION.

Leader: G. L. Byers, Chairman, Regional Technical Committee

Cooperators: The twelve Northeastern Agricultural Experiment Stations, and A.E.R.D.-ARS, and C.S.E.S.S. (USDA)

PROGRESS OF WORK AND PRINCIPAL ACCOMPLISHMENTS:

New sensing elements for forage cutting force determinations were designed. Results of bending and compression tests from three varieties of alfalfa suggest (1) a difference in strength characteristics between varieties; (2) an increase in strength with stage of maturity; and (3) a large difference in strength between varieties due to drying. A hydraulically operated pellet press was constructed and instrumented for hay pellet die studies.

Experimental work towards an evaluation of the mass shear strength of haylage has been completed and the data are in the process of being analyzed. Equipment was set up for blowing air through single packages of forage and multiples of packages from the same plenum chamber. Approximately eighty-five controlled laboratory tests have been conducted for determining exposed layer drying rates as a function of air temperature, air absolute humidity, air velocity, plant species and plant treatment.

Baled hay with moisture content above 30% (wet basis) will begin spontaneous heating unless placed in a drier. Accompanying this will be an increase in thermophilic bacteria and a decrease in mesophilic bacteria. Plants subjected to steam at 212°F for two minutes dried significantly faster than unsteamed plants. Any method devised to increase the drying rate of alfalfa will be most effective if it exposes the greatest transverse cross-sectional area of the stems. The application of vacuum drying principles to forage was investigated and representative drying curves developed.

Methods of incorporating radioactive water into an alfalfa plant were studied and techniques to follow the release of this water during the drying process were investigated. To learn the specific volume of alfalfa pieces at particular moisture contents, a sand displacement method was used.

USEFULNESS OF FINDINGS:

Determinations of the strength characteristics of alfalfa stalks may be useful in evaluating the more desirable variety and forage form for designing forming machinery. Results indicate that hay pellet geometry has a significant effect on the stability and handling durability of pellets made at moisture contents ranging from 28-44 percent. The vacuum principle of drying alfalfa provides a closed system for complete collection and analysis of material removed from the plant during the drying process. Improved drying methods for forage can result in substantial monetary savings. It has been found that drying is

accelerated by a small increase in the bulk density of the drying bed and by particular stem piece configuration. The results of baled hay drying experiments show a wide range of heat utilization values. If the factors that cause high heat utilization can be identified, then drying system design criteria will become more scientific. Radioactive water is readily absorbed by a cut plant in quantities resulting in levels of activity that can be readily counted.

Title: PROJECT NEM-22 - FACILITATING THE MARKETING OF SEEDS THROUGH IMPROVED TESTING PROCEDURES

Leader: Frederick E. Hutchinson, Chairman, Regional Technical Committee

Cooperators: Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York (Geneva and Ithaca), Pennsylvania, and Rhode Island Agricultural Experiment Stations, F.C.R.B., ARS, USDA - C. S. Garrison, V.O.R.B., S.E.S.D., ARS, USDA and B.S.B., A.M.S., USDA

Thirty samples of alfalfa seed were tested during the year. Ten of these were known varieties and twenty were varieties or mixtures of varieties unknown to the workers. The ten varieties plus ten of the unknowns were grown in the field in Maine, Maryland, New York and Pennsylvania. One group of unknowns was grown in Maine and Pennsylvania while ten were grown in New York and Maryland. All 30 of the samples were tested in the greenhouse and growth chambers in New York. Field notes were taken on bloom date, flower color, stem diameter, plant height and plant type. The greenhouse-growth chamber tests in New York consisted of notes on leaf serrations on 12 day old seedlings grown in the greenhouse and stem length of 30 day old seedlings grown in the growth chamber with cold nights and short photo-periods. Flower color and percent bloom notes were also obtained on six weeks old seedlings grown under continuous light. The information obtained made it possible to make relatively accurate estimates of the components of the unknown samples both on the basis of field tests and on the basis of greenhouse and growth chamber tests. Varieties that were similar in height, bloom date, and flower color were relatively difficult to separate while those that differed in these respects were easy to separate.

Studies were continued in the growth chambers in New York to find ways to promote blooming in a short time. With the best treatments blooms or flower buds were produced on 85% of the red clover plants, 72% of the birdsfoot trefoil plants, and 80% of the alfalfa plants in 5 weeks. An average of 58% of the plants of the three varieties of timothy produced heads in 5 weeks with Climax producing heads on 75% of the plants. These four species varied in their response to light and temperature conditions so that the best environmental conditions had to be worked out for each species.

Timothy seedlings were grown under 16 different environmental conditions. It was found that Essex produced fewer tillers than Climax or Commercial when short photoperiods were used. Under all conditions Climax produced

more green weight per plant than Essex or Commercial but with long photoperiods usually produced fewer tillers. Thus, with long photoperiods Climax produced only half as many tillers as Essex per gram of green weight.

Experiments were continued to refine the growth chamber techniques used to test unknown alfalfa seed samples for fall dormancy. By using 8 hours of light from cool white fluorescent tubes and incandescent bulbs per day with temperatures of 25°C during the light period and 5°C during the dark period it was possible to cause the stems of California Common to grow to 5 times the length of the stems of Ranger. Intermediate varieties such as Williamsburg, Buffalo, and DuPuits could be separated from the northern varieties, Narragansett and Ranger. Birdsfoot trefoil varieties were grown under 36 different combinations of light quality, light intensity, and temperature. Several of these treatments made it possible to distinguish Empire from European or Viking. Cold temperatures during the dark period tended to make the plants more nearly decumbent. When grown under warm white fluorescent light and 8 hour photoperiods with temperatures of 20°C during the light period and 5°C during the dark period, 60% of the plants of Empire were classed as decumbent. Under the same conditions none of the European or Viking plants were decumbent.

Varieties of forage crops were tested for their reaction to several chemicals during the year. Differential varietal responses to two of these chemicals were observed.

In addition to the field and growth chamber studies, experiments to evaluate flower color, plant type, plant height, spectral transmission curves and spectrographic analyses for additional alfalfa varieties were conducted at Pennsylvania. Comparative top to root measurements and susceptibility to bacterial wilt were studied for varieties grown in the field. In Maine several alfalfa varieties were evaluated for luminescence of ground seeds, reaction to dilute phenol, and content of lecithin, saponin and cholesterol. Work in Massachusetts dealt with the ability of seeds to germinate under adverse conditions.

Title: PROJECT NE-24 - NUTRITIVE EVALUATION OF FORAGES

Leader: J. W. Bratzler, Chairman Regional Technical Committee

Cooperators: The 12 Northeastern States and The U. S. Regional Pasture Research Laboratory, D.C.R.B., ARS and cooperative State Experiment Station Service.

Harvest date influence upon nutritive value was studied using alfalfa, orchardgrass, timothy, and brome grass. The regression of dry matter digestibility on date of harvest was calculated using data collected over the last six years (Maryland). The equation was $Y = 68.4 - 0.32X$ where Y is equal to the number of days from April 30 to harvest date. Other grasses and legumes studied during the year also showed decreases of digestible dry matter of approximately 0.5% and of protein about 0.35% per day of delay in harvest date. Digestible energy decreased for each day's delay of harvest of two varieties of timothy after June 1st (New Hampshire) of 15, 25, and 40 Calories per Kg. of dry matter of the hays fertilized with 50, 100, and 150 lb. of nitrogen per acre, respectively. With alfalfa grown under irrigation, the digestibility of dry matter, protein, and energy (Dairy Cattle Research Branch ARS) declined only .29, .23, and .26 percentage units per day, respectively, during the period of harvest from May 25 to July 15. Nutritive value of aftermath timothy forages (Maine) decreased with delays in harvest from 5 to 7 weeks, and from 7 to 9 weeks after initial cutting date.

Previous annual reports have indicated the value of nitrogen fertilization for increasing yields, protein content, and apparent protein digestibility of grasses. Level of nitrogen fertilization was found (Delaware) to be without effect on true digestibilities, but biological values of the protein declined as the level of nitrogen fertilization increased. A decline in DE (digestible energy) values of approximately 7% was obtained (Massachusetts) when the level of nitrogen fertilization was increased from 325 to 650 pounds per acre per season for four grass species which were cut 4 times. Reports were again somewhat conflicting as to the effect of nitrogen fertilization upon the acceptability of forages by livestock. No effect was reported for first-crop timothy (Maine and Rhode Island). Increased acceptability of orchardgrass (Delaware), no effect with brome grass and a pronounced decline in acceptability of orchardgrass (Pennsylvania).

Alfalfa was fed long and in pelleted form to milking cows, yearling heifers, 10-12 week-old calves, and yearling wethers (Maryland). Pelletting depressed digestibility but increased intake except by the milking cows. Nutritive value indices did not rank four types of hay the same for each group of animals. Intake of 3rd cutting alfalfa (New York) which had been finely ground and pelleted was greater than that of loose, chopped hay and the DE values decreased at higher intakes of the pelleted hay but did not for the chopped hay.

Some data (New York) show that the dry matter content of a forage at the time of harvest is a good index of its DE value. However, the relationship of dry matter percentage of alfalfa to its energy digestibility (Dairy Cattle Research Branch-ARS) was changed by flood irrigation which decreased dry matter percentage with no apparent effect on energy digestibility.

The effect of drying temperature upon the digestibility and acceptability of alfalfa and orchardgrass hays was determined with sheep (New Jersey). Apparent digestibility of crude protein decreased with increased temperature. Alfalfa dried at the lowest air temperature of 150°F was superior in acceptability while the highest drying temperature of 200°F produced the orchardgrass hay with the highest voluntary consumption. The third and final year's comparison of forage harvested on the same calendar date and preserved both as silage and barn-dried hay (Vermont) indicated very little difference in nutritive value and milk production from cows.

All varieties of timothy except Essex had similar DE values at same dates of harvest (New York); Essex timothy was 2.5 to 3.5 percentage units higher. Trials with two varieties of orchardgrass, common and S-37 (Delaware), on three harvest dates, showed no significant differences in nutritive values between varieties. Two varieties of alfalfa, DuPuits and Williamsburg, and two varieties of orchardgrass, S-37 and Potomac, (Maryland) were harvested on the same date. In dry matter digestibility, Williamsburg was about one percentage unit higher than DuPuits alfalfa and S-37 was about 3.5 percentage units higher than Potomac orchardgrass.

Hays harvested at various locations within a state, but on the same date (New Hampshire and Vermont), were approximately equal in nutritive value.

Previous findings of in vitro methods of forage evaluation were confirmed (West Virginia). A highly significant correlation existed between in vivo dry matter digestibility and in vitro cellulose digestion or gas production at 36 hours, and a lower correlation between intake of forage and in vitro coefficients at any time interval between 4 and 16 hours. With the latter relationship, forage species had a pronounced effect. Possible relationships of certain characteristics of the rumen fluid with the digestibility and acceptability of forages were studied (Massachusetts).

Subjection of forages to mild acid treatment (U. S. Regional Pasture Research Laboratory) showed that the hemicelluloses were hydrolyzed more readily in forages of high digestibility than in those of low digestibility. Further refinement of the methods is needed.

Studies were made using the new detergent lignin for measuring the digestibility of forages, using the ratio technique (Dairy Cattle Research Branch-ARS). A comparison with chromic oxide in 22 total collection trials with cows gave a correlation of +0.96 between digestibility estimated by lignin ratio compared with total digestibility, whereas the corresponding correlation for chromic oxide was +0.91. Acid detergent fiber of forages, as determined according to newly standardized procedures, gave higher correlation with digestibility than did crude fiber as determined by the AOAC method.

Differences in the acceptability or voluntary consumption of forages by livestock strongly indicate the need for more carefully controlled supplementation of forages with proper concentrates for their most efficient utilization. Incorporation of measures of acceptability of forages with their DE values should aid materially in the improvement of feed programming systems that are already in use.

Studies on the nitrogen metabolism of forages grown under different levels of nitrogen fertilization will help to determine the optimum levels of use for nitrogen fertilizer.

Information as to the maximum temperature that can be used for the heat drying of forages for hay, without resulting in significant declines in DE values or acceptability, should aid greatly in the development of more efficient hay drying systems.

Title: PROJECT NE-28 - BREEDING AND EVALUATION OF IMPROVED VARIETIES OF FORAGE CROPS ADAPTED TO THE NORTHEAST

Leader: R. E. Anderson, Chairman Regional Technical Committee

Cooperators: Connecticut (Storrs), Maine, Maryland, New Hampshire, New York (Cornell), Pennsylvania, Rhode Island, and West Virginia Agricultural Experiment Stations; F.C.R.B. and S.E.S.D., ARS, USDA, and A.S.T.A.

PROGRESS OF WORK AND PRINCIPAL ACCOMPLISHMENTS:

Field trial testing was conducted in seven states. Prolonged drought reduced yields significantly of trials located in West Virginia, Maryland, Pennsylvania, and New York. Future performance of several trials may be impaired. Some seedings made in 1962 in these states failed in establishment. Sites of the testing and major accomplishments are summarized for each species.

Alfalfa (Connecticut, Maine, Maryland, New York, Pennsylvania, and West Virginia)---Fourth-year production data and stand estimates were obtained in Connecticut, where major interest is in long-lived alfalfas. All states continued trials through second-year production of available varieties and recently formulated synthetics under an "early cut" management and a "normal cut" management. The wilt-resistant Flemish type was markedly better than DuPuits in second year production at Connecticut and at a New York site where wilt developed early. The effect of adding wilt resistance to Narragansett and Flemish alfalfa should be critically tested in 1963.

First-year data were obtained at New York and Pennsylvania on trials evaluating strain synthesis procedures for alfalfa.

Bromegrass (Maryland, New Hampshire, New York, Pennsylvania, and West Virginia)---Nine second-cycle synthetics, were evaluated under several managements for the second harvest year in all five states. Several synthetics appeared to give more vigorous growth than Saratoga. The Maryland trial, which appeared best in this series, indicated differences in Syn. 1 vs Syn. 2 performance on three synthetics where this was compared.

Progenies of selected clones were seeded in Pennsylvania and New York; harvest data on a 1961 seeding of similar materials were obtained. Drought seriously curtailed yields in both 1961 trials and caused the new seeding to fail in New York.

Orchardgrass (Maryland, New York, Pennsylvania, and West Virginia)---All states continued field evaluation of seven experimental synthetics under two management systems. Three states seeded polycross progeny trials of three maturity groupings in 1962.

Two Pennsylvania synthetics in the medium maturity group equalled or excelled the earlier maturing check strains in dry matter production. Greater yield potential may be obtained from combinations of available clones in the medium-early maturity range.

Timothy---Cage seed production of materials for strain synthesis studies was begun in 1962 at New York. Eight parental clones were selfed in 1961; the S_1 progenies produced S_2 seed and single-cross seed in 1962 in 14 cage isolations. Eighteen cage isolations were fall-planted for S_3 seed, single-cross seed and double-cross seed in 1963.

Orchardgrass---Syn-2 generation isolation increases were established for eleven experimental synthetics formulated for regional evaluation. Syn. 1 and Syn. 2 seed of these will be produced in 1963 at Pennsylvania.

Selfed progenies of ten superior clones, selected on the basis of earlier regional testing, were established in row nurseries for cage production of sib progenies in 1963.

Bromegrass---Syn-2 generation seed of experimental synthetics 59-10 and 59-12 was produced at New York. Syn-1 seed of 11 leaf-spot resistant single crosses was grown at New Hampshire. Advanced generation selfs, open-pollinated lines, and various F_1 combinations have been made at New York and New Hampshire using mutant types. The U. S. Regional Pasture Laboratory produced polycross seed of 18 clones with resistance to Stagonospora and Helminthosporium.

Alfalfa---Contract production of 29 cage increases in California was successful; yields ranged to more than 3600 grams per cage. These increases included 1st and 2nd generations of double-cross combinations, 2nd and 3rd advanced generations of single crosses, and Syn-3 of synthetics involving the clones in the methodology study.

Polycross seed was obtained on 98 selected clones resistant to Pseudopeziza leaf spot and bacterial wilt at Logan, Utah in 1962 to augment small seed production in 1961.

USEFULNESS OF FINDINGS:

Results from trials of polycross progenies will aid in determination of the region of adaptation of new breeding materials, as well as their yield potential, quality, and disease resistance. Evaluation of experimental synthetic varieties, combined on the basis of clonal and polycross characteristics, provides the data which will aid selection of new, improved varieties with desired agronomic qualities.

The alfalfa trials for study of strain synthesis procedures offered opportunity to evaluate the effectiveness of various breeding methods in combining clonal materials. Because the clones were carefully chosen for performance and adaptation in the Northeast, superior varieties are a hoped-for adjunct of these trials.

Development of satisfactory and reliable seed increase procedures provides: (a) adequate quantities of seed of the polycrosses, synthetics, and hybrids needed for the testing phases of the project, and (b) opportunity to plan ahead for 3 to 5 years the necessary step-wise development of improved varieties with assurance that planting stocks will not be a limiting or delaying factor.

WORK PLANNED FOR NEXT YEAR:

Data will be collected from the alfalfa, orchardgrass, and brome-grass trials established in 1960, from the alfalfa strain synthesis study and the brome-grass polycrosses seeded in 1961, and from the 1962 brome-grass polycross progenies and the three maturity groupings of orchardgrass polycrosses.

New trials to be established in 1963 include: alfalfa strain synthesis studies, experimental synthetics of timothy and orchardgrass.

Seed production is scheduled for stocks needed for strain synthesis studies in alfalfa, timothy, orchardgrass, and brome-grass; for experimental synthetics and genetic marker stocks of brome-grass; for experimental synthetics and hybrids in birdsfoot trefoil.

Title: PROJECT NE-29 - MANAGEMENT AND PRODUCTIVITY OF PERENNIAL GRASSES

Leader: G. A. Jung, Chairman Regional Technical Committee

Cooperators: The 12 Northeastern Agricultural Experiment Stations, Forage and Range Research Branch and C.S.E.S.S., ARS, USDA

Management studies with pure stands of brome grass, orchard grass, reed canary grass, and timothy, as described in the 1960 Annual Report (p. 48), were continued at eight state experiment stations.

Drought reduced yields severely at four locations and reduced yields slightly at two others. The lack of precipitation not only reduced total yields but resulted in a poor seasonal distribution of yields. Small aftermath yields often resulted in few significant differences among aftermath treatments.

Cutting at four physiological stages of growth in the first harvest generally resulted in increased total yields and decreased aftermath yields with an advance in maturation. However, the amount of increase in total yields or decrease in aftermath yields varied greatly among locations and species. Certain locations reported that the distribution of yields throughout the season was affected by this spring cutting management. Also of prime importance was the fact that cutting at the prejoint and early head stages of growth resulted in serious stand losses. In this respect, brome grass and timothy appeared to be least tolerant, reed canary grass intermediate, and orchard grass most tolerant to the cutting management. Timothy appeared to be more tolerant to mismanagement at northern than at southern locations.

Increased nitrogen fertilization resulted in higher yields of brome grass, orchard grass, and reed canary grass and variable yield responses with timothy. Persistence of timothy and orchard grass decreased, whereas persistence of brome grass and reed canary grass was variable with high levels of nitrogen fertilization. Connecticut reported severe winter killing of S-37 orchard grass with high rates of nitrogen fertilization.

Cutting the first aftermath at heights of 1 1/2" or 3 1/2" generally did not influence yield or persistence materially. This response undoubtedly was modified by drought.

Measures of etiolated growth indicate unexplained variability among species, stations and years. While the biological measure of relative concentrations of reserves is promising, improvement of this technique is planned so that results may be more fully evaluated.

Nutritive evaluations of each species harvested during 1962 under certain selected management treatments are underway using an artificial rumen technique. Cooperative animal trials have been conducted at several locations using a few selected forages in cooperation with NE-24.

A manuscript has been submitted for publication prior to June 30, 1963, titled "Seedling Management of Grass-Legume Associations in the Northeast". It reports a portion of the NE-29 project in progress from 1954-1958. In summary, it concludes that decision on the use of a companion crop must be based on a knowledge of local situations. Clipping treatments used on new seedlings must be based on the growth of the species involved as well as the progression of weather elements. No single prior recommendation for seedling management can serve all situations throughout the Northeast during different years.

USEFULNESS OF FINDINGS:

It has become quite clear during the three years the four perennial grasses brome grass, orchard grass, reed canary grass, and timothy have been harvested that they will respond to management as much as legumes. Furthermore, it has been found that the four species did not respond in the same way to the managements under study.

Thus far the data collected are important because they indicated: (1) that perennial grasses represent a large forage potential which could result in greater flexibility of farm management, (2) certain cutting managements can severely reduce stands of brome grass and timothy, and (3) forage yields can be distributed differently throughout the season with cutting and fertilization management. The yield data will become even more meaningful when the nutritive data are available.

Title: PROJECT NE-35 (REVISED) - ANALYSIS OF NORTHEASTERN CLIMATIC VARIABLES AND THEIR RELATIONSHIPS TO PLANT RESPONSE

Leader: M. T. Vittum, Chairman Regional Technical Committee

Cooperators: Connecticut (New Haven and Storrs), Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York (Ithaca and Geneva), Pennsylvania, Vermont, and West Virginia Agricultural Experiment Stations; ARS, C.S.E.S.S, USDA; and Weather Bureau, USDC

Some of the reports are applicable to forage problems. In New Jersey net radiation over bluegrass at the Marlboro field station was compared with total incoming radiation measured at New Brunswick. A highly significant correlation was found and a regression equation computed which makes it possible to reliably estimate net radiation over bluegrass using data on total radiation from a nearby location.

Work done in the inflated plastic enclosures developed by Maine in 1961 was continued, and the design of the experiment was modified to allow use of multiple regression as the method of statistical analysis. In 1962 light intensity accounted for nearly 60 per cent of the variation in CO₂

assimilation while air temperature and CO₂ content accounted for only 10 per cent of the variation.

Studies were continued at New York (Ithaca) on the influence of solar radiation on net CO₂ assimilation. Moisture stress reduced the rate of net assimilation at given light intensities. Wind movement and temperature patterns were determined to better identify the exact conditions within the chamber.

At Connecticut (Storrs) radiant energy available for evaporation of water from crops was measured by determining difference in loss of water from black and white atmometers at Coventry, Windsor, and Middletown. Results indicate that potential evapotranspiration is rather uniform over the state.

At New York (Geneva) evapotranspiration of 7 different species has been studied for 11 years. Climatological data for the entire 11-year period have been punched on cards, and a program has been prepared for Burroughs 220 calculation and tabulation of total and average pan evaporation, Blaney-Criddle ET, Thornthwaite ET, and Penman ET for periods between excessive soil moisture sampling dates. Actual evapotranspiration for each of the 7 species will be correlated with the evapotranspiration as calculated from the three formulas (Blaney-Criddle, Thornthwaite, and Penman).

At Delaware the use of black sprayed mulches in July and August increased soil temperatures to the point where young plants were killed by the direct and indirect effects of temperature. Increased water loss was a major factor as the increased water lost due to the higher soil temperature more than offset any effect the mulch might have on retarding evaporation from the soil surface. White mulches were more beneficial than black during this period. Black mulches applied at planting time caused more rapid germination of both crop seeds and weed seeds. Black mulches also increased the rate of early growth when soil temperatures were below optimum.

At Delaware faster germination was obtained by increasing the soil temperature in the spring by means of black sprayed mulches on the soil surface. These same mulches were often detrimental when used in mid-summer.

Title: PROJECT NE-43 - PROFITABILITY OF ALTERNATIVE FORAGE SYSTEMS FOR
NORTHEAST DAIRY FARMS

Leader: William E. McDaniel, Chairman, Regional Technical Committee

Cooperators: The 12 Northeastern Agricultural Experiment Stations;
C.S.E.S.S., ARS, USDA; and F.E.D., E.R.S., USDA

Analyses of over 600 dairy farm records for the Oneida-Mohawk Region of New York were completed and preliminary results published. In general, the amount of milk sold per cow increased as crop yields increased. The most profitable combination of feed was a liberal amount of roughage (six to seven tons of hay equivalent per cow) obtained from high crop yields and moderately heavy purchase of feed.

In Connecticut research indicates it is profitable for representative farms to produce forage locally, but emphasis should be upon high production rotations, which include corn silage and alfalfa and high fertilizer levels. As herd sizes are increased on the same amount of land, corn should be fertilized more heavily and the rotation with alfalfa should be shortened to include more corn silage relative to alfalfa. Rhode Island, consulting with Connecticut, is attempting through linear programming, to determine the most efficient forage crop rotations with various input-output data. Two hundred sixteen solutions will be programmed. The limits of input-output data, within which solutions are being sought, were determined through a survey of research workers in the Northeastern States.

New Jersey and Delaware have coordinated their research on silage production and harvesting. Identical survey forms used in both states were developed in consultation with Maryland and Massachusetts. Preliminary analysis indicates the cost of producing and harvesting an acre of corn silage in Salem County, New Jersey, was \$121 as compared to \$96 in Sussex County, New Jersey, and to \$89 in Delaware. As data were collected and analyzed similarly, the items varying in cost are easily identified as fertilizer, labor and machinery.

Maryland obtained cost data for different capacities of silos including trench, bunker, concrete stave tower and glass-lined tower. Massachusetts obtained information from 55 farms on unloading corn silage, grass silage and haylage from silos. Performance rates were determined for mechanical and manual removal methods of forage from both vertical and horizontal types of silos. The range of unloading speed in mechanical top unloaders for identical equipment and quite similar forage was from 46 pounds per minute to 214 pounds per minute and averaged 96.8 pounds per minute. Manual top unloaders averaged 92.2 pounds per minute while tractor scoop unloading of horizontal silos averaged over 500 pounds per minute.

The study clearly indicated the low earnings of the average milk producer in the state of Delaware and Salem County, New Jersey. The operator's labor income averaged \$2,280 in Delaware, and \$988 in Salem County, New Jersey.

Suggestions for improvement in efficiency are being taken directly to the farmers through established extension channels and a reduction in the cost-price squeeze and more economical milk production should eventually benefit consumers.

Title: PROJECT NE-45 - ROOT AND CROWN DISEASES OF ALFALFA AND CLOVERS

Leader: Houston B. Couch, Chairman Regional Technical Committee

Cooperators: Delaware, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and West Virginia Experiment Stations; The Pasture Research Laboratory and Forage and Range Research Branch, ARS, USDA

This project was activated July 1, 1962.

ORGANISMS ASSOCIATED WITH ROOT AND CROWN ROT

Fungi---Using both newly established field plots, and plots that were 1 year old or older, isolation studies have been conducted by the various cooperators, with samples taken at regular intervals.

At least 23 species of fungi, representing 18 genera, have been isolated from either root or crown tissues, the surface of roots, or soil intimately associated with the roots of alfalfa and clovers. The New Jersey station reported that Cephalosporium spp., Penicillium spp., Myrothecium sp., and Fusarium solani were found commonly on the surface of red clover roots. In addition, 9 different fungi were isolated from the roots and crowns of young red clover plants. The New York, Rhode Island, New Hampshire, and Pennsylvania studies found the roots of field-grown red clover and alfalfa to be infected with Fusarium roseum, F. solani, and F. oxysporum within 5 weeks from the time of planting. At this time, no evidence of root breakdown could be seen. In the New Jersey field plots, the roots of 1 month old red clover were also found to be infected with a Fusarium sp.--with no apparent discoloration of tissue.

The New York and New Jersey stations have studied the topographic orientation of root colonizing fungi. New York reported that Fusarium spp. accounted for the majority of fungal isolates regardless of whether the tissue was sampled from the fibrous roots, the epidermis and outer cortex, or from the inner cortex and stele. However, the proportion of Fusarium isolates to Penicillium and/or Aspergillus isolates was higher in the inner cortex and stele. The New Jersey work indicated that with red clover, the main roots were more frequently colonized than the branch roots. Furthermore, although the fungi from crowns and roots were generally the same, the incidence of Cephalosporium spp. was greater in the crowns.

The nuclear condition during growth of Fusarium spp. hyphal tips was studied by phase microscopy and a polynuclear and uninuclear condition reported in different species. The relation of time and process of nuclear division to pathogenic specialization and the mechanism of infection is under study at the Rhode Island Station.

Root Feeding Insects---The U. S. Regional Pasture Laboratory reported that red clover grown in the greenhouse in soil infected with the root feeding insect Calomycterus setarius and Fusarium spp. resulted in more severe root rot than when red clover was grown in soil with either insects or fungi alone. In addition, when soil was treated for field control of Sitonia and root borers, a significant reduction in root rot resulted.

Nematodes---The New Hampshire station and the ARS reported that the nematode, Pratylenchus penetrans, is capable of causing a discoloration and rotting of Ladino clover roots indistinguishable from that caused by fungi. Varietal and species differences in susceptibility to this nematode have been noted in Trifolium.

ROLE OF PHYSICAL AND BIOLOGICAL ENVIRONMENTS IN ROOT AND CROWN DISEASE DEVELOPMENT

Physical Environment---In New York, the correlation between applications of potash at levels of 0 and 320 lbs./acre to alfalfa and severity of (a) root rot, (b) foliar fungal infection, (c) stand persistence, and (d) populations of fungi associated with the roots was studied. Initial data indicated slightly lower root and foliar infections and slightly higher stand counts for the plots that received potash than for those that did not receive potash. The number and relative frequency of fungal isolates was essentially the same for both treatments.

Ladino white clover seedlings have been selected by ARS in New Hampshire for resistance to freezing-induced root deterioration. Promising plant material from these tests is now being increased for further studies.

Biological Environment---The influence of alteration of balance of soil microflora on root disease development in red clover was studied by (a) greenhouse trials in which autoclaved soil, non-steamed potting soil, and soil in which red clover had been grown, served as the potting media, and (b) field trials that utilized plot areas of known previous continuous cropping sequences. In the former work, conducted by the U. S. Pasture Laboratory, it was found that the most severe root rot developed in soil in which red clover had been previously grown. The primary pathogen in these trials was Thielaviopsis basicola.

The latter series of experiments were conducted at the Delaware station. These trials revealed that seedling losses were more extensive in plots that had been previously planted to continuous red clover or soybeans. Disease loss was lowest in plots grown to continuous corn or wheat.

RELATIONSHIP BETWEEN PLANT CONSTITUTION AND DEVELOPMENT OF ROOT AND CROWN DISEASES

Foliar Diseases---New York reported that plots of DuPuits alfalfa either inoculated or not inoculated with Colletotrichum trifolii, or Phoma medicaginis var. herbarum or Stemphyllium botryosum were rated for severity of root rot, stand depletion, and fungi associated with the roots. Initial data do not indicate any significant effect of the treatment on the factors measured.

Cutting Practices---Preliminary greenhouse studies at New Hampshire suggested that height of cutting may affect the rate of root rot development. Trials are being conducted in New York to determine the effect of two-, three-, and four-cut management systems on root rot, stand depletion, and fungi associated with the roots in one-, two-, three-year-old stands of DuPuits alfalfa.

Host-Parasite Relationships---Histopathological studies conducted by ARS and the New Hampshire Experiment Station indicated that the nematode, Pratylenchus penetrans, caused hypertrophy of the epidermal and cortical cells of Ladino white clover. Cellular breakdown and eventual disruption of tissues resulted, making identification of root regions difficult.

Techniques---At the West Virginia station a technique utilizing a sand planting medium is being employed as a rapid identification method for comparing the pathogenicity of isolates obtained from alfalfa and red clover on the seedlings of these legumes.

In New York, fungal isolates are being tested for their relative pathogenicity to alfalfa seedlings and for their capacity to produce pectolytic and cellulolytic enzymes in liquid media and on autoclaved alfalfa root tissue.

At the U. S. Regional Pasture Laboratory, the following inoculation methods have been used in pathogenicity tests: (a) infested autoclaved soil, (b) autoclaved soil cultures in petri dishes, (c) conidial and mycelial suspensions, (d) infested vermiculite, and (e) infected alfalfa roots. The first two methods were found to be the most effective.

Title: PROJECT NE-48 - SOIL-PLANT-WATER RELATIONSHIPS

Leader: Allan B. Prince, Chairman, Regional Technical Committee

Cooperators: The 12 Northeastern States; S.W.C., S.C.S., C.S.E.S.S., USDA;
and W.B., U.S.D.C.

A thermocouple psychrometer to measure water potential in plant tissue and a controlled environment test chamber to control transpiration rate have been developed at the Connecticut Station (New Haven).

Apparatus and techniques for the measurement of the fate of labeled water in soils and plants under controlled environmental conditions have been partially developed at the New Hampshire Station.

At the New York Station (Ithaca) apparatus has been assembled for determining soil water characteristic curves by three or four distinct methods on a single sample.

The study of the dynamics of water transmission through glass bead and soil column systems in the laboratory has been initiated at the Pennsylvania Station.

Soil moisture utilization studies were carried out at the Maryland Station with three vegetable crops using a neutron moisture meter and depth probe.

Forage irrigation plots were used as a test area at the Pennsylvania Station to secure information on the orders of magnitude of soil-root flux of soil moisture and of soil-soil flux of soil moisture under natural rainfall and at two levels of supplemental irrigation. Although not conclusive, there were indications that where root extraction causes a large gradient between depth zones that an appreciable inter-zone flux may occur. This was reflected in the relatively larger net flux out of the 24" - 32" zone of the birdsfoot trefoil and brome grass plots.

In connection with the objective of relating physiological conditions in plants to water stress it was found that increasing the osmotic pressure of the nutrient solution resulted in a decrease in rate of growth and transpiration. The higher the osmotic pressure, the greater the effect. The rate of transpiration was retarded when approximately 2 atmospheres pressure had been added and growth was retarded when approximately 3 atmospheres pressure had been added.

PASTURE RESEARCH AT STATE STATIONS

CONNECTICUT (STORRS)

Title: EFFECTS OF HIGH RATES OF NITROGEN AND IRRIGATION ON YIELD
AND CHEMICAL COMPOSITION OF FORAGE GRASSES

Leaders: E. R. Larssen, E. J. Rubins, and J. R. Guttay

Forage grasses---Yield of orchardgrass increased with increasing nitrogen fertilization up to 375 pounds per acre in 1961 and 300 pounds per acre in 1962. Higher rates had little effect on yield but increased the nitrate content in the plant tissue beyond the limit considered safe for animal feeding. Evidence of nitrogen deficiency was marked at 125 and 100 pounds per acre. The response of orchardgrass to irrigation was not marked but was greater than that of timothy.

In 1961 yields of timothy increased with nitrogen fertilization up to approximately 200 pounds per acre. In 1962 increases were obtained up to 300 pounds per acre. The corresponding rates per cutting were higher in 1961 than in 1962 and this may have caused the decrease in yields at nitrogen rates beyond 200 pounds per acre in 1961. When the amount of nitrogen applied to timothy approached or exceeded 100 pounds per cutting, tissue nitrate levels increased greatly and in some instances exceeded minimum safe levels for animal feeding.

Title: APPLICATION OF HIGH RATES OF FERTILIZER TO ALFALFA

Leaders: R. I. Munsell and L. Barber

Vernal alfalfa received seven rates of limestone (1-16 tons) and seven rates of superphosphate (200 to 1600 lbs.) during establishment in 1959. Stands continued uniformly good on all plots in 1962. Yields during the three seasons were similar at all fertility levels. The value of this study will appear in later years when the response should indicate the effectiveness of a stockpile for fertilizers. During the first three seasons, yields from plots stockpiled were similar to yields from plots receiving annual top-dressings of phosphorous.

Title: RATES AND SOURCES OF LIME

Leaders: R. I. Munsell and L. Barber

Alfalfa-timothy and birdsfoot trefoil-timothy were established in 1959, on previously unlimed acid (pH 5.2) soil, and limed at several rates using two carriers. Rates were from two to eight tons per acre and included a substitution of 1.75 tons of dolomitic by 1.25 tons of hydrated lime for each rate. No difference appeared among trefoil-timothy yields as a result of differential lime application. Yields of alfalfa-timothy receiving six and eight tons per acre, however, were significantly greater than after applications of two, three and four tons per acre. Substitution of 1.75 tons of dolomite by 1.25 tons of quick-acting hydrated lime did not result in significantly different yields at any lime level.

Title: WEED CONTROL IN FORAGES

Leader: R. A. Peters

The advantages of using herbicides for the control of weeds in new legume seedings were particularly obvious in 1963 because of the drought prevailing in many areas.

Under the relatively favorable rainfall conditions at Storrs, 2,4-DB, dalapon + 2,4-DB, EPTC, dacthal or diphenamid resulted in yields of 1 1/2 tons or over on July 25th, following an April 19th seeding. The check plots yield less than one-half as much. The best treatment (EPTC), resulted in a yield just short of 2 tons in July and another ton in October.

While yields were limited by drought at two sites within the state, the advantage to the legume was apparent. Plots on which weed control was poor had virtually no stand by the end of the summer.

DELAWARE

Title: THE INFLUENCE OF CUTTING HEIGHTS, NITROGEN FERTILIZATION AND IRRIGATION ON PLANT SURVIVAL AND ROOT AND DRY MATTER YIELDS OF ORCHARDGRASS

Leader: W. H. Mitchell

This study is a follow-up of work at this station which established that under certain management systems high mortality of orchardgrass plants could be expected.

During 1962 a significant yield reduction, associated with the 1" cutting treatment, was noted at the second harvest. As the season progressed the voids left by dead orchardgrass plants were filled by weedy species. This made it impossible to measure accurately the seasonal effect of cutting treatments and may explain the significant cutting X height of cut interaction.

Three to four fold yield increases were obtained with nitrogen treatments. The greatest response was obtained with split applications. Under this treatment, however, high orchardgrass mortality and subsequent weed intrusion was noted.

Root samples taken from all plots to a depth of 24" showed that nitrogen fertilization reduced root weights with the most significant differences occurring at the 8-24" depth. The most striking reduction in root weights was related to the split applications of nitrogen.

Supplemental irrigation increased yields, encouraged weedy species and depressed root growth.

A question raised by the data is whether all orchardgrass varieties respond in a similar manner. Such information might be valuable in a breeding and development program.

The same general procedures will be followed in 1963 with the exception that one-half of each plot will be treated with a chemical for crabgrass control to prevent a masking of stand and yield differences by crabgrass.

MAINE

Title: PRODUCTIVITY OF ALFALFA SEEDLINGS

Leaders: C. S. Brown and R. F. Stafford

A new project to determine the productivity of alfalfa-grass seedlings, with and without an oat companion crop, was initiated in 1962. DuPuits and Narragansett alfalfas, Saratoga brome and Masshardy orchardgrass were included in the study. Microclimatic data are being obtained to permit future seasonal comparisons.

An herbicide (2,4-D Butyric) was used in certain treatments, with excellent control of lambsquarters and red-rooted pigweed resulting. Weed yields in the first cutting at two months ranged from 2.2 tons d.m. for the no herbicide-no oats treatment to 0.2 tons for the herbicide + oats treatment. Without an herbicide, oats cut weed growth in half and replaced 1.2 tons of weeds with 0.8 tons of oat forage.

Oats sown at 50 lbs. per acre depressed alfalfa yields in the first cut when compared to plots treated with herbicide. After the first cut no further

effects of oats were noted, with excellent alfalfa stands and good second cutting yields obtained.

Title: UPTAKE OF TOPDRESSED POTASSIUM BY ALFALFA AND TIMOTHY

Leaders: C. S. Brown, R. F. Stafford and P. N. Carpenter

For the second consecutive year pure stands of alfalfa and timothy were topdressed with 0 to 300 lbs. K_2O , on soils varying in texture from sandy loams to heavy silty clay loams (1960 Annual Report, page 61). Seasonal uptake of K and the effect of K rate on mineral content were determined.

A single annual application of 200 lbs. K_2O in the fall or early spring maintained adequate K supply throughout the season, even on the lighter soils. Split applications reduced luxury consumption somewhat and resulted in small increases in K uptake by the third crop.

Massive applications of KCl (200 to 300 lbs. K_2O) have had no consistent effect on Ca and P contents. The major effect appears to be a modest depression in Mg percentage.

The fate of unrecovered K topdressed in the field experiment appears to vary widely between the soils under study. In a supplemental leaching experiment conducted in greenhouse pots, distilled water equivalent to 10 inches precipitation removed 72% of a 1,000-lb. K application from the C horizon of the Merrimac sandy loam. In contrast, only 1% leached from the C horizon of the Suffield silty clay loam. Fixation appears to be a major fate of unrecovered K on the heavier soils.

Title: FORAGE HANDLING SYSTEMS FOR DAIRY FARMS

Leaders: R. J. Rowe, B. E. Plummer, B. L. Bondurant

The present emphasis of this project is on the extension of flail cutting and flail pickup methods to a complete hay harvesting system including storage facility and mow drying.

A system for hay harvest involving cutting and conditioning with a flail harvester, pickup and loading with a flail harvester, transport and unloading with a self unloading wagon and placement in storage with an elevator was established and studied. Data were obtained on time involved and material handled for each operation in the system. The long chopped hay obtained from the flail harvester seriously limited elevator capacity and load carrying capacity of wagons. A rotary mower was modified, including provision for offset operation, in an attempt to improve its performance as a mowing and conditioning tool. Use of this machine to date has resulted in bunching of hay when deposited in the swath interfering with drying. Further

work with the chopped hay handling system in order to improve system capacity and obtain quantitative data on performance of system components is planned. Study of methods of designing systems for hay harvest which will optimize returns are to be investigated.

MARYLAND

Title: RED CLOVER BREEDING INVESTIGATIONS

Leader: R. C. Leffel

Each of the 4 S₁ families from non-inbred clones of red clover contained only one of the two possible genotypes homozygous for sterility alleles. Pseudo-self-compatibility did not appear to be closely associated with specific sterility alleles. Pseudo-self-compatibility of clones was considerably affected by temperature: all clones were pseudo-self-compatible to some degree at 90°F. Diallel crosses among 6 clones were evaluated for pseudo-self-compatibility. Pseudo-self-compatibility appears to be a heritable, quantitative characteristic. Polycross, singlecrosses and self progeny were established in field plantings.

Title: FORAGE CROP VARIETY EVALUATION IN MARYLAND

Leaders: R. C. Leffel, A. M. Decker and N. A. Clark

Alfalfa varieties were maintained at College Park for persistence evaluation only. Chesapeake red clover continued its excellent performance among red clover varieties. Empire types and imported strains of birdsfoot trefoil varieties were lowest yielding at the Forage Research Farm, Ellicott City, while improved varieties of the upright types were best. All of the upright types produced equally well. Evaluation of three Bermudagrasses in the Piedmont, Maryland Area was concluded at the end of the fourth harvest year. Midland was the most productive variety, Greenfield was nearly as productive but was more susceptible to disease. Common Bermudagrass was the least productive of the three.

Title: LADINO CLOVER BREEDING, DISEASE, AND INSECT INVESTIGATIONS

Leader: R. C. Leffel

Ladino white clover persistence and management studies were concluded and indicated that persistence is an entomological - pathological complex with emphasis on the entomological aspect. Plots protected by insecticides were as persistent as those treated with both insecticides and fungicides, and

more persistent than all remaining treatments. Management factors of potash fertilization, winter mulch, and reseedling practices did not affect persistence in this study conducted at optimum levels of management. Segregation of sterility alleles upon selfing non-inbred clones of ladino was in the 1:2:1 ratio for some families; other results were impossible to interpret. Pseudo-self-compatibility was not associated with sterility alleles. Cytological studies suggested that pseudo-self-compatibility in ladino clover is explained on an antigen-antibody principle between pollen and style.

Title: FORAGE CROP INSECT INVESTIGATIONS

Leader: A. L. Steinhauer

Chemical Control of Alfalfa Insects---Experiments on chemical control of alfalfa weevil, pea aphid and meadow spittlebug are continuing on an annual basis. No new chemicals, with the exception of Telodrin, were found to give better control of alfalfa weevil than is already attainable with heptachlor. Studies show Telodrin to be about 4 times as toxic to alfalfa weevil as heptachlor. Preliminary studies with silica gel powder have prompted further experimentation for the future.

Cultural Management of Alfalfa in Relation to Alfalfa Weevil Abundance---An experiment has been inaugurated to study the long term effect of various cultural manipulations of alfalfa stands in relation to alfalfa weevil abundance, crop yield and crop quality.

Alfalfa Weevil Ecology---Cage studies on alfalfa were begun in the fall of 1962 to determine the movements of alfalfa weevil into and out of alfalfa and the relative importance of fall and spring oviposition.

Title: SOD SEEDING ESTABLISHMENT TRIALS

Leader: A. Morris Decker

A uniform planting of Midland Bermudagrass was fertilized with 200, 400 and 800 lbs. of nitrogen per acre during the 1961 growing season. In the fall of 1961 rye was sod-seeded into these plots and fertilized with 0, 20, 40 and 80 lbs. of N at the time of seeding. Rye-vetch was seeded into a set of plots which had received 200 and 400 lbs. of N on the Midland. A third set with 200, 400 and 800 lbs. of N on the Midland was left with no sod-seeded crop. Forage yields of the rye, vetch and Midland were obtained during the 1962 growing season. Total yields increased with each increment of nitrogen. Midland-rye yields were slightly higher than the Midland-rye-vetch yields. The first harvest of Midland was reduced slightly by the sod-seeded rye but this decrease was more than offset by the additional yield from the rye. After the first harvest of Midland there was no

difference. Total yields were increased by adding nitrogen to the sod-seeded rye with 200 and 400 lbs. of N but not with 800 lbs.

Successful fall establishment of birdsfoot trefoil in bluegrass sod was obtained for the second year. A disc type opener was superior to a wing type and both were superior to the conventional opener. A packer wheel improved stands with the disc opener but not with the wing. There appeared to be a slight advantage to using insecticides to protect the young seedlings.

Title: INFLUENCE OF SOIL TEMPERATURE ON FORAGE GROWTH

Leaders: A. Morris Decker and N. H. MacLeod

Engineering changes in design of the equipment were made which allowed chilled or heated water to go directly to mixing tanks and then to a grid system in each field plot rather than merely used to cool or heat a separate quantity of water being pumped through the grid system. After installation of this new equipment it was checked out to insure equal delivery of thermal energy to all plots. Ethylene glycol was added to the system to provide anti-freeze protection. The system was checked out at 70° and 90° F. During these tests temperatures of the liquid being pumped through the separate grid system changed very little even though ambient temperature fluctuated widely.

Title: MANAGEMENT STUDY OF SUMMER ANNUALS

Leader: N. A. Clark

Sudangrass, Pearl Millet, and a commercial sorghum-Sudangrass hybrid are being compared under two levels of nitrogen fertilization, two cutting heights (18 and 30 inches) and three stubble heights (2, 4 and 8 inches). In 1962 Pearl Millet under the 30 inch cutting schedule outyielded Sudangrass slightly, but the sorghum-Sudangrass hybrid produced twice as much dry matter as the Pearl Millet or the Sudangrass. Nitrogen fertilization was not significant nor was stubble height.

Title: RESPONSE OF BERMUDAGRASS TO VARIOUS RATES OF POTASSIUM AND
 NITROGEN

Leaders: C. B. Kresge and A. M. Decker

Potassium and nitrogen applications to Midland Bermudagrass were continued as previously outlined (1960 Annual Report, pages 67-68). The importance of the balance of nitrogen and potassium was exemplified. At the 200 and 400 pound per acre rates of nitrogen, a 2 to 1 ratio of applied nitrogen to potassium provided maximum yields in 1962. This amount of potassium was sufficient to keep the soil level of available potassium just above the low range. Maximum yield in 1962 was 5.63 tons of dry matter per acre, obtained with 400 pounds of nitrogen and 166 pounds of potassium per acre. At the same nitrogen rate, yields decreased with decreasing potassium (4.61 and 3.30 tons with 83 and 0 pounds of potassium, respectively). The bermudagrass was attacked by Helminthosporium leaf spot disease. Incidence of disease was most severe on plants receiving no applied potassium. It is important to the farmer who uses heavy rates of nitrogen (200 or more pounds per acre) on bermudagrass to pay particular attention to the availability of other essential elements, particularly potassium. About a 2 to 1 ratio of nitrogen to potassium apparently is an optimum application on most soils found in the Piedmont Region of Maryland.

Title: RESPONSE OF MIDLAND BERMUDAGRASS TO TWO SOURCES OF NITROGEN,
 THREE RATES OF NITROGEN AND THREE LEVELS OF LIME

Leaders: A. M. Decker and J. H. Axley

A uniform planting of Midland Bermudagrass with a pH of 6.5 was used for the study. Ammonium nitrate and ammonium sulfate were applied at 200, 600 and 1800 pounds of N per acre in four equal split applications. Some plots receive no additional lime, others will receive sufficient lime to theoretically correct nitrogen acidity while others will receive twice the required lime. The lime is applied each year during the winter months in a single application.

Dry matter yields ranged from 0.89 to 6.89 tons per acre this first year of study. Yields were slightly higher where lime was not applied this first year. This was true for both sources of nitrogen. The largest increase in dry matter production was between 200 and 600 lbs. of N rather than between 600 and 1800 lbs. N per acre.

Nitrogen recovery data are being obtained along with the effect of these treatments on soil pH.

Title: THE EFFECTS OF SOURCE OF NITROGEN AND NUMBER OF APPLICATIONS ON DRY MATTER PRODUCTION AND NITROGEN RECOVERY OF MIDLAND BERMUDAGRASS

Leaders: A. Morris Decker and J. R. Miller

Residual dry matter yields were obtained in 1962 following dry matter yield determination and nitrogen applications as previously outlined (1960 Annual Report, page 70).

Forage production was more uniformly distributed with four rather than two applications of nitrogen. Greater efficiency in forage production of Midland was usually obtained with ammonium nitrate rather than urea. Nitrogen content of the forage and nitrogen recovery was also higher with ammonium nitrate. Residual forage yields obtained in 1962 after nitrogen had been applied in 1960 and 1961 showed a slight carry over of nitrogen at the first harvest of all treatments. By the end of the season there were no differences in yield except where 800 lbs. of nitrogen had been applied. In this case yields were also higher for the ammonium nitrate than the urea.

Title: EFFECTS OF CLIPPING HEIGHTS AND FREQUENCY OF HARVEST ON THE PERFORMANCE OF MIDLAND BERMUDAGRASS

Leader: A. Morris Decker

Clipping treatments and fertilizer applications were continued for the third harvest year, as previously outlined (1960 Annual Report, page 71). Dry matter yields ranged from 1.42 tons per acre with 200 lbs. N per acre, seven harvests and a 4-inch stubble height to 8.24 tons per acre with 600 lbs. N per acre, three harvests and a 2-inch stubble. There was a decrease in yield as the stubble height was increased from one to four inches. There was a significant increase of 600 over 200 lbs. of N. There was an increase of 5 over 7 harvests and 3 over 5 harvests. There was a tendency for plots with the low stubble heights to have higher weed infestation. Residual harvests yields will be obtained during the 1963 harvest season to measure residual effects. Protein and fiber values of samples are also being determined.

Title: EFFECTS OF NITROGEN RATES AND CLIPPING FREQUENCY ON THE PERFORMANCE OF MIDLAND BERMUDAGRASS

Leader: A. Morris Decker

All treatments were left unfertilized and uniformly harvested in 1962 in order to measure residual treatment effects as a result of clipping and nitrogen treatments imposed during the past three years (1960 Annual Report, page 70).

Average dry matter yields for 1959-61 ranged from 0.80 T/A with zero N and 5 cuts to 8.28 T/A with 600 lbs. N and 3 cuts. Yields over the 3-year period decreased with the zero and 100 lb. N rate, remained about the same with 200 lbs. of N and increased with 400, 600 and 800 lbs. of N per acre. Two residual harvests made in 1962 resulted in yields ranging from 0.29 tons per acre on plots that had received no N with six cuts to 4.88 for 800 lbs. N and 3 cuts. At the first harvest there was a residual N effect starting with the 100 lb. rate, but by the second harvest it was apparent only at the 400, 600 and 800 rates. There was little residual effect due to number of harvests. Percent N in tissue increased with N level and harvest frequency (1.24 to 3.45% N). Percent N recovery with 3 cuts decreased as N was increased from 100 to 800 lbs. while with 4, 5, 6 and 7 cuts recovery was low at 100 lbs. high at 200 lbs. with a steady decline up to 800 lbs.

Title: RESPONSE OF ORCHARDGRASS TO VARIOUS SOURCES OF NITROGEN AND TIME OF THEIR APPLICATION

Leader: C. B. Kresge

Various sources of nitrogen were applied at different times to orchardgrass as previously outlined (1961 Annual Report, page 46). At the single 70 pound per acre nitrogen rate, the December 15 application was as effective as the March 15 application in terms of dry matter yield of orchardgrass forage. One exception was ammonium nitrate which was less effective in December than March. This may have been caused by leaching of the nitrate ion during the winter. The September 15 and October 30 applications were inferior to the December and March additions. The orchardgrass grew actively into December and the nitrogen applied in early fall was absorbed by the plant and "used up" before spring. When 140 pounds of nitrogen per acre was split into two or three applications, applying 1/2 of the nitrogen in September or October was too early for sufficient carryover into the next year. However, these applications would have been desirable for fall grazing the same year. No outstanding differences between highly soluble nitrogen sources were found except that urea produced lower yields than other sources ($\text{NH}_4 \text{NO}_3$ and $(\text{NH}_4)_2 \text{SO}_4$) when applied in September or October.

Urea-formaldehyde did not perform as well as the more soluble sources in the first year. Data from 1962 indicate that nitrogen can be applied economically in late fall or early winter when work loads are reduced. However, nitrogen content of forage fertilized in December may be slightly lower than that receiving nitrogen in March.

Title: LEGUME-GRASS MIXTURES IN RELATION TO DIFFERENTIAL NITROGEN FERTILIZATION

Leader: C. B. Kresge

Differential nitrogen applications were made on legume-grass associations containing varying percentages of legumes (1961 Annual Report, pages 47-48). In 1962 significant yield increases were obtained with each increasing increment of nitrogen at all ladino clover percentages. However, larger increases occurred when the legume content was below 20%. In the case of red clover-orchardgrass, the results differed in that no response to 100 pounds of nitrogen per acre occurred when the percent legume was 20 or above. In fact, yields of the higher percent legume plots were lower. There were no significant differences in alfalfa-orchardgrass yields caused by percent legume or nitrogen rate. No definite trends were noted in nitrogen contents of forage owing to changes in botanical composition of the sward during the growing season. Generally, applying nitrogen to legume-grass mixtures, when the legume comprises up to 20 to 25% of the mixture, appears to be economically sound. However, in a dry year when ladino clover at larger percentages failed, nitrogen did benefit the remaining orchardgrass.

Title: GROWTH AND DEVELOPMENT OF FORAGES AS AFFECTED BY POTASSIUM FERTILIZATION

Leaders: C. B. Kresge and V. A. Bandel

The importance of proper potassium balance in forage crop growth and development was exemplified in a number of experiments. In one of these, dry matter yields of Pearl Millet were increased at moderate rates of phosphorus application only when potassium was added in sufficient quantity. Maximum yields were obtained with 25 to 45 pounds of phosphorus and 180 to 240 pounds of potassium per acre. This relationship as well as the interaction with magnesium will be studied in 1963, using orchardgrass.

Potassium has long been known for its beneficial effect on winter hardiness of forages. Possible reasons for this were revealed in another study. Potassium increased the inorganic electrolyte level in the cells of orchardgrass roots. These electrolytes could act as an antifreeze to reduce freezing of root cells during winter months. In alfalfa root cells,

concentrations of organic materials, such as sugars, were increased by potassium. Higher concentrations of these substances could reduce freezing by preventing dehydration of root cells. Also in alfalfa roots, potassium caused xylem vessels to be larger in diameter and more evenly distributed. This phenomenon would allow for "antifreeze materials" to be present in larger quantities and be effective in a greater portion of the root. Also, root constricting organisms, such as nematodes, would find it more difficult to constrict the larger xylem vessels.

Title: THE EVALUATION OF SUMMER ANNUAL PASTURES FOR LACTATING DAIRY COWS

Leaders: N. A. Clark, R. W. Hemken, and J. H. Vandersall

Piper Sudangrass, Gahi No. 1 Pearl Millet and a commercial sorghum-Sudangrass hybrid were compared as a summer annual pasture for dairy cows. In previous years these forages produced equally well under pasture conditions but in the exceptionally dry season of 1962 the sorghum-Sudangrass hybrid was statistically significantly higher in dry matter yields than the other two pastures. Individual cow milk production was equal on all three pastures, but butterfat production was depressed in the cows assigned to the Pearl Millet pasture.

Title: THE COMPARISON OF NITROGEN FERTILIZED GRASSES WITH A GRASS-LEGUME MIXTURE FOR LACTATING COWS

Leaders: N. A. Clark, R. W. Hemken, and J. I. Leslie

The 1962 grazing season was the last year for the comparison of the three levels of nitrogen (100, 200, 300 lb. per acre) on orchardgrass compared with an orchardgrass-ladino clover control treatment. The production of all pastures was much lower than during previous seasons because of a severe drought. Added nitrogen increased the carrying capacity over the orchardgrass-ladino control; however, the results indicate little or no advantage of 300 lb. nitrogen over the 200 lb. level. While milk production per cow was highest on the grass-legume mixture, no adverse effects of nitrates were noted on the high levels of fertilization.

Midland Bermudagrass produced the greatest carrying capacity and continues to show promise as a quality pasture as well as one having high production per acre when handled properly. During the drought, the Midland Bermudagrass continued to produce some forage even though production per acre was much lower than during the two previous seasons.

Title: GRASS AND LEGUME COMBINATIONS FOR BEEF PRODUCTION

Leader: A. Morris Decker

Data for two pasture systems (1. rye in prepared seed bed, orchardgrass-ladino clover, and sudangrass; 2. sod-seeded rye, bluegrass, Midland Bermudagrass, bluegrass, rye in prepared seed bed, and sod-seeded rye) were compared for the second grazing season using Angus steers as test animals. Grazing was begun on March 28 for both systems and was ended November 2 for system 1 and November 30 for system 2. Total beef per acre was 128 lbs. more for system 2 than for system 1. This was a greater advantage than found the first year. The management of system 2 was also easier than that for system 1. Forage production was also better maintained during the summer drought of 1962.

MASSACHUSETTS

Title: EFFECTS OF RATES OF NITROGEN AND HARVEST MANAGEMENT ON YIELDS OF ORCHARDGRASS

Leaders: Mack Drake, W. G. Colby, and E. Bredakis

In 1960 and 1961, management studies with high rates of nitrogen supplied to Massachusetts Hardy strain of orchardgrass showed slow recovery and seriously limited growth after the second harvest (late July). The combination of delayed first harvest, low (1-1/2") height of cut, and high rates of nitrogen applied in the spring plus nitrogen applied after each cutting, produced the most serious injury to plants, delaying recovery and limiting yield following the second harvest. Early harvest and 3 inch height of cutting resulted in more rapid recovery and much greater yields.

Plant response in 1962 differed from 1960 and 1961. Poor recovery and growth occurred after the second harvest of early (boot stage) initial cutting as well as following the normal (early bloom) initial cutting date in 1962. Abnormally hot, dry weather persisted from June 10 to July 9. The second harvest of the early initial cut treatment was made June 28 when the weather was extremely hot and the soil was dry. Irrigation was delayed until July 5. We believe this period of high temperature-low moisture from June 28 to July 5 was critical. During this period June 28-July 5, the canopy of the second growth of the normal initial cut treatment plots remained providing such benefits as shading to reduce soil temperature. It is reasoned that with low temperature, respiration was reduced and less depletion of carbohydrate reserve occurred.

The effects of harvest management and rates of nitrogen application on fructose in basal stem tissue as an indication of carbohydrate reserves in the plant are being studied. Samples of basal stem tissues were taken

from each plot within 3 hours after each harvest. In the first and second harvests, per cent fructose decreased with added increments of nitrogen. At the initial harvest the fructose content of basal tissue was lower for early (boot stage) than for normal (early bloom) harvest. This indicated an important increase in carbohydrates in the basal tissue during the 10 day interval between early and normal harvest. For example, per cent fructose in the basal tissue of early as compared to normal harvest was 8.6 vs 4.4, 6.1 vs 3.6, and 6.5 vs 2.2 for 50, 100 and 150 pounds N/a, respectively. This also indicates the effect of nitrogen in reducing the fructose content.

At the second harvest, fructose was higher in the basal tissue of the early as compared to normal harvest. Also at the second harvest, normal harvest date, the per cent fructose was lower in the basal tissue of plots cut at 1.5 inch than at 3 inch. It is important to note that the management combination of high N, low cut (1.5 inch) and normal harvest (late) which produced the greatest injury following the second cutting in the years 1960, 1961, 1962, also produced plants with basal tissue containing the lowest per cent of fructose in 1962.

Samples of basal tissue will be collected 10 and 20 days after each harvest in addition to those on the harvest day, to study effect of management on periodic changes in carbohydrate content as reflected by fructose in the basal tissue.

Title: INVESTIGATIONS OF FORAGE CROP INSECTS IN 1962

Leaders: F. R. Shaw and W. J. Fischang

Population Studies of Insects of Forage Crops---During the period from 1958 through 1961, we have made extensive studies of the insect populations on forage crops in Massachusetts throughout the growing season. In 1962, as a result of the revision of our forage crop insect project, investigations of forage insect abundance and distribution were greatly curtailed, except for the alfalfa weevil (Hypera postica).

In order to have some information concerning the abundance and distribution of alfalfa weevil, leafhoppers and meadow spittlebug (Philaenus spumarius) primarily, we conducted a survey of 25 fields of alfalfa or alfalfa combinations in October 1962. Collections were made in Berkshire, Franklin, Hampden, Hampshire, Bristol, Plymouth, Essex and Middlesex Counties.

Collections were made by taking 100 sweeps with a 15" net. The insects were then killed and stored in cardboard containers until they could be identified. We recorded only the insects of economic importance, representing approximately 10,000 individuals. The data obtained appear in Table I on page 55.

As far as the percentage of each group of insects is concerned, the data obtained in the 1962 fall survey agrees in general with that for the entire season of 1961. In some instances, there were considerable differences, which we wish to discuss further.

In 1961, leafhoppers comprised 12.1 percent of the total collection; in October 1962, they represented 12.3 percent. The most abundant species in 1961 included potato leafhopper (Empoasca fabae), six-spotted leafhopper (Macrostelus fascifrons), clover leafhopper (Aceratagallia sanguinolenta) and Graminella nigrifrons in that order. In the 1962 fall collection, six-spotted leafhopper represented only 2.3 percent of all leafhoppers, while Endria inimica was the most abundant species. It should be noted that in 1961 six-spotted leafhopper was most abundant in early summer, and E. inimica was primarily a fall species. Thus there is more similarity between the two years' collections than is first apparent. In Berkshire County, Errastunus ocellaris was conspicuously abundant for the first time, comprising 4.7 percent of all leafhoppers.

In 1961, beetles represented 3.6 percent of the total, with the alfalfa weevil (Hypera postica) being most abundant (38.8 percent of all beetles). In 1962, we observed the maximum populations of alfalfa weevil that we have had. In late May, we collected as many as 12 (larvae and adults) per sweep in Berkshire County. The highest counts in our fall survey included 14 adults and 15 larvae per 100 sweeps in Easton (Bristol County), 6 adults and 27 larvae in Southwick (Hampden County) and 3 adults and 10 larvae in Topsfield (Essex County). Counts in other counties averaged less than 10 weevils per 100 sweeps.

It is of interest that the percentage of clover root curculio (Sitona hispidula) was greater in the 1962 fall collections than in 1961. It represented 41.6 percent of all beetles in 1962 but only 6.9 percent for the year's collections in 1961. A Japanese weevil (Calomycterus setarius) also increased from only 1.2 percent of all beetles in 1961 to 8.0 percent in 1962.

Beneficial insects and allies represented 7.8 percent of the 1962 total as compared with 2.6 percent in 1961. A damsel bug (Nabis fesus) represented 49.2 percent of all beneficial forms, an increase of 28.1 percent over 1961 (or 11.2 percent over October collections of 1961). Coccinellids amounted to 27.8 percent in 1961 but decreased to 20.7 percent in October 1962. Spiders increased from 0.5 percent of beneficial forms in 1961 to 1.3 percent in the fall of 1962. A flower bug (Orius insidiosus), which represented 41.3 percent of the beneficial species in 1961, was reduced in relative numbers and was included in the miscellaneous beneficial group in 1962.

Table I - Census of forage crop insects in Massachusetts, October 1962.

Insect name or group	Percent of group	Percent of total
Aphids		63.8
<u>Macrosiphum pisi</u>		
Leafhoppers		12.3
<u>Endria inimica</u>	27.9	3.4
<u>Empoasca fabae</u>	26.3	3.2
<u>Aceratagallia sanguinolenta</u>	20.5	2.5
<u>Graminella nigrifrons</u>	7.8	1.0
<u>Errastunus ocellaris</u>	4.7	0.6
<u>Scaphytopius acutus</u>	4.0	0.5
<u>Helochara communis</u>	3.8	0.5
<u>Macrosteles fascifrons</u>	2.2	0.3
Miscellaneous leafhoppers	2.6	0.3
Plant bugs		8.6
<u>Lygus lineolaris</u>	89.3	7.7
<u>Adelphocoris lineolatus</u>	5.9	0.5
<u>Adelphocoris rapidus</u>	3.5	0.3
Miscellaneous plant bugs	1.3	0.1
Beetles		4.5
<u>Sitona hispidula</u>	41.6	1.9
<u>Hypera postica</u>	39.2	1.8
<u>Calomycterus setarius</u>	8.0	0.4
<u>Popillia japonica</u>	7.6	0.3
Miscellaneous beetles	3.6	0.2
Spittlebugs		1.9
<u>Philaenus spumarius</u>		
Lepidoptera		0.6
Grasshoppers		0.5
Beneficial insects and allies		7.8
<u>Nabis ferus</u>	49.2	3.9
Coccinellids	20.7	1.6
Spiders	17.1	1.3
Chrysopids	8.8	0.7
Miscellaneous beneficial	4.2	0.3

Percentages calculated to nearest tenth.

Control of Forage Crop Insects---In tests on alfalfa, in one experiment, and on adjacent strips of alfalfa, birdsfoot trefoil and ladino clover, in a second experiment, 13 insecticides were tested against forage crop pests. Insects were collected at four intervals following treatment. Analyses of the variance of numbers of insects collected were calculated separately for the leafhopper complex, aphids and adults of the meadow spittlebug. Tukey's range test was used to determine differences among means.

The results from the experiment on alfalfa showed that, against leafhoppers, methyl-ethyl Guthion at 0.5 lb. actual per acre and Imidan at 1.0 lb. gave superior control at one and five days after treatment. Imidan at 0.5 lb., Bayer 39007 at 1.0 lb. and Shell SD 7438 at 0.5 lb. were significantly different from the untreated controls at both one and five days after treatment. However, Telodrin at 0.25 lb. and Dimetilan at 1.0 lb. demonstrated no promise for the control of leafhoppers.

Aphids were significantly reduced on the day following treatment by Imidan at both levels, methyl-ethyl Guthion, Bayer 39007 and Shell SD 7438, while again Dimetilan and Telodrin were inferior. All of the former materials except Bayer 39007 maintained significant control through 14 days after treatment.

The range test employed failed to show any differences among treatment means for spittlebug data.

In the experiment involving three crops, leafhoppers were controlled through the fifth day after treatment by American Cyanamid Experimental Insecticide 47300 at 1.0 lb., Diazinon AG-500 and AG-250 at 1.5 lbs. each and American Cyanamid 38023 at 1.0 lb. Cygon at 0.5 lb. gave control only at one day, while American Cyanamid compounds 43356 and 43064, both at 1.0 lb., showed no significant control.

All insecticides in this experiment showed initial significant reduction of aphid populations, but no control was evident at five days after treatment.

Once again there were no significant differences among treatments for spittlebug data. In both experiments this lack of significance may have been largely due to the relatively small numbers present.

Release of Parasites of the Alfalfa Weevil---In cooperation with Dr. Carl Blickenstaff, Entomology Research Division, ARS, we released the following parasites of the alfalfa weevil in Massachusetts:

Name of parasite	Date of release	Number live parasites	Location
<u>Bathyplectes curculionis</u>	May 1, 1962	661	Leverett
<u>Bathyplectes curculionis</u>	May 1, 1962	780	Seekonk
<u>Bathyplectes curculionis</u>	May 15, 1962	379	Leverett
<u>Bathyplectes curculionis</u>	May 15, 1962	392	Seekonk
<u>Tetrastichus incertus</u>	May 22, 1962	981	Leverett
<u>Dibrachoides druso</u>	May 22, 1962	200	Leverett

Larvae of the alfalfa weevil will be collected this spring and the degree of parasitization determined.

Biological Studies of the Alfalfa Weevil (W. H. Ziener)---(1) Field investigations: The first larval occurrence for the year of 1962 was observed and reported from Sunderland, Massachusetts on April 25. These larval populations had hatched from overwintering eggs. The first adult report was also recorded from the same location on May 15. The initial adults were sexually mature overwintering insects. Copulation was first observed from Leverett, Massachusetts on May 22. Populations of both larvae and adults gradually increased until the first week in June, after which time a mass exodus from the alfalfa fields took place. During the latter part of the year, the weevil did not return to the fields in any numbers around Amherst and adjacent areas.

(2) Laboratory investigations: A Cabinet was built in order to control temperature, relative humidity, photoperiod, and different light wave lengths. Alfalfa weevil eggs were exposed to these control conditions and the life history determined.

NEW HAMPSHIRE

Title: IMPROVEMENT OF SMOOTH BROMEGRASS, RED CLOVER AND ALFALFA

Leaders: G. M. Dunn, L. J. Higgins, and J. Wright

Syn-2 seed was produced and plots established in 1962 for comparison of Syn-1 versus Syn-2 generations of 15 diallel crosses of brome grass. Parental clones were selected primarily for resistance to brown leafspot and good aftermath growth.

Scissor emasculation of brome grass continued to be effective in the greenhouse, but was relatively ineffective in the field. This may be due to differences in moisture conditions. The best time to emasculate was 4 days prior to anthesis.

Sibbing and selfing were continued among brome grass mutants. Some yellow x yellow crosses produced 90-100% of yellow or intermediate colored plants. Some fairly large F₂ populations were obtained by selfing F₁ plants from self-fertile normal x mutant crosses.

In a preliminary study on pollen dispersal of spaced plants, most of the pollen contamination from a dominant green clone occurred when it was planted adjacent to 2 yellow clones. No significant contamination occurred when the yellow clones were planted at several distances (50 to 750 feet) from the green clone.

New Hampshire red clover seed is being obtained from isolated potted plants by pollination by bees in the greenhouse. When sample seed is available, replicated variety trials will be carried out to check yield, persistence and perennial characteristics.

Title: IMPROVEMENT OF WHITE CLOVER

Leaders: G. M. Dunn and R. A. Kilpatrick (in cooperation with the Forage and Range Research Branch, ARS, USDA)

Preliminary studies suggest that the rate of root rot development of white clover is influenced by harvesting. In one greenhouse test, 56% of the plants died following the first harvest.

The meadow lesion nematode (Pratylenchus penetrans) attacks the root tips of young seedlings, causing a discoloration and rotting indistinguishable from that induced by fungi. Histological studies of clover roots injured by nematodes and 2,4-D showed hypertrophy of cells, cellular breakdown, and eventual disruption of tissue. Differences between the 2 types of injury were evident in early stages.

Fifteen lines of white clover seedlings were exposed to simulated winter condition in freezing chambers. Of 4500 plants tested, 38% survived. Selections were reduced to 65 plants which were cloned and transplanted to the field for observation.

Yield differences among treatments were non-significant in 1962 for the 1958 and 1959 dieldrin plots at Northwood. Yield plots were established in 1962 for comparison of Syn-1 versus Syn-2 of 10 diallel crosses.

A small but probably non-significant increase was obtained in persistence of the primary taproot in the absence of stolon rooting. In the growth chamber, stolons of Wisconsin white clover branched more than Vermont polyploid or Pilgrim, but stolon internode length was shortest on the polyploid strain.

NEW JERSEY

Title: SILAGE INVESTIGATIONS

Leaders: M. A. Sprague and B. Brooks Taylor

Experimental silo techniques were improved during 1962 to the extent that 1 1/2 ton silos were built on 6' X 6 1/2' pallets. To these pallets were fixed removable wheels and axles for individual transit, weighing and storage. Separate stub axles with attached wheels and tires were inserted into the removable axles, and the entire assembly with mounted sheet metal forms hauled behind the chopper in the field. After filling was completed the pallet-trailer was drawn to its desired location and the unit weighed on portable field scales. After weighing, jacks were placed under the axles and the stub axles were removed and the unit lowered onto cinder-blocks. Such an arrangement provided easy weighing before and after filling and ensiling. Similarly, wheels could be replaced in order to remove the individual units to feeding areas. This technique appeared to have merit in that it represents a larger mass than laboratory bottles or plastic cylinders would. The uniformity between duplicate silos and throughout the silage masses as determined by extensive sampling offers confidence of representative units.

During 1962 corn and sorghum were harvested at early and late maturities, following low, medium and high levels of nitrogen fertility. Though the data are not complete there is some indication of increased efficiency of preservation at higher levels of fertility. High levels of hydrolyzable carbohydrates in the green forage were associated with lower dry matter losses. Samples of gasses evolved were drawn at intervals following sealing and found to stabilize within the plastic bags after approximately 50 to 70 hours. Large quantities of carbondioxide were found as expected. Oxygen was nearly exhausted after ten hours. More complete chemical analyses of the silages are currently underway. Studies during 1963 growing season will include orchardgrass and alfalfa grown in pure stands.

Successful storage of fresh-cut alfalfa at near freezing temperatures suggested that this may be developed into a practical method of preserving field nutrients. Initial cooling was accomplished with dry ice and storage was in a walk-in refrigerator. Anaerobic atmospheres are essential to maintain constant temperature. Fermentation is prevented so long as temperature of the mass is maintained below 35°F.

Title: THE USE OF HERBICIDES IN THE CULTURE OF MIDLAND BERMUDAGRASS

Leaders: Robert W. Duell and Richard D. Ilnicki

The development of practical techniques for the control of Midland Bermudagrass, through research, has resulted in the addition of this warm-season hybrid to the list of forage species recommended in New Jersey. Dalapon at 10 lb./A active plus cool-season tillage designed to expose rhizomes resulted in excellent control of Midland Bermudagrass. In many plots, where such treatment was employed, actual eradication was achieved. Amitrol plus amitrol T, each at 2 lb. active/A, also gave excellent control even at light tillage.

The use of herbicides to facilitate the establishment of Midland Bermudagrass (which is propagated vegetatively) is also being investigated. The most promising materials found thus far are simazine at 1 1/2 lb. active/A and casoron at 2 lb. active/A.

Title: PERMANENT PASTURE FERTILIZATION

Leaders: Robert W. Duell and Donald W. Graffis

Yields obtained from beneath movable 4' x 4' x 1.5' wire cages on plots in permanent pastures being grazed by cattle reflected the generally dry season. In one of four locations throughout the state, however, yields were from 1500 to 5000 lb. higher than at other locations. In 1961 highest yields were obtained from applications of nitrogenous fertilizers in early April, but in 1962 early March applications were best. Fall yields in 1962 equalled spring yields at one location.

Cages were essential to demonstrate the response of pasture grasses to nitrogenous fertilizers. The cages preserved islands of representative growth, but outside the cages the cattle consistently and completely ate the evidence of the response of the grass to the fertilizer treatment. After two years of working with cages on farmer's pastures throughout the state, it was concluded that even three replications per location produced results that were too variable to be of much use. In addition, the effort in transporting, re-locating cages on the plot after each harvest, repairing cattle-damaged cages, and accounting for missing plots where cages were moved by cattle, was too great to warrant continuance, particularly considering the information obtained.

Title: PASTURE RENOVATION STUDIES

Leaders: M. A. Sprague, R. D. Ilnicki, R. W. Chase and W. H. Tharrington

A thesis was presented in which a new herbicide testing technique was devised. This method used ED-50 (effective dose for 50% kill) measurements which when used and tested with mixtures of dalapon and cacodylic acid on bluegrass and orchardgrass gave representative comparisons. The method involved the plotting of logarithms of data as probit transformations from toxicity tests and the comparing of curves where different proportions of chemicals were used in mixtures. Cacodylic acid and dalapon used together were tested for their effectiveness in killing weedy grasses and broad-leaved plants. Some synergism was found with cacodylic acid indicating that dalapon was more effective when cacodylic acid was included. Bluegrass was more susceptible to cacodylic acid than orchardgrass. This would suggest the removal of bluegrass and other unwanted plants from old orchardgrass pastures prior to re-establishing the legumes.

A preliminary greenhouse study was initiated to determine the effects of surfactants on the effectiveness of cacodylic acid. Six surfactants were used at 0.3, 0.1 and 1% concentrations of each. Major differences were observed on corn and soybeans in the effectiveness of this herbicide at two rates as influenced by the different surfactants. Additional evidence was observed of the translocation of cacodylic acid in grass species.

Title: POTASSIUM EXTRACTION BY FORAGES FROM SOILS OF VARYING
POTASSIUM SUPPLY CAPACITY: A GREENHOUSE STUDY

Leaders: Harlan E. White and Robert W. Duell

Ten harvests were made of Kentucky bluegrass, orchardgrass, birdsfoot trefoil, and alfalfa growing in pots containing either Lakewood sand (low in available potassium), Nixon clay loam (medium in available potassium), or Colts Neck fine sandy loam (high in available potassium).

Orchardgrass foliage was found to be high in K when the soil K was readily available. As the soil K was depleted by cropping, the orchardgrass K content was markedly reduced in all soils. Birdsfoot trefoil was consistently higher in K content than alfalfa and Kentucky bluegrass. The K content of birdsfoot trefoil was reduced less by crop depletion of the soil than was that of other species.

Eight harvests were made of Kentucky bluegrass, orchardgrass, and Midland Bermudagrass in pots of the same soils described above, but subjected to three levels of nitrogen fertilization. Chemical analyses of the forage are not yet complete.

Yield data, and hence total K removal data, have not yet been summarized from either of these experiments. The vigor of all the forages has decreased markedly since the experiment was initiated, but no visible symptoms of potassium deficiency were ever detected.

Title: NITROGEN X POTASSIUM X GRASS SPECIES INTERACTIONS

Leaders: Harlan E. White and Robert W. Duell

Six grasses, viz. Kentucky bluegrass, orchardgrass, tall fescue, timothy, reed canary grass, and brome were compared under both hay and pasture types of management. These grasses were fertilized with N and P only. The potassium contents of species and their yielding capacities were found to be in general agreement with trends previously reported in this project. The K content of the forage of all species at the pasture stage was higher than that at the hay stage. The yields of all species but Kentucky bluegrass were higher at the hay stage. The pounds of K removed under the two management regimes were similar for most species. The removal of K was greater for Kentucky bluegrass at the pasture stage, and greater for brome at the hay stage.

In another experiment Kentucky bluegrass, orchardgrass, and Midland Bermudagrass were subjected to two levels of nitrogen and three levels of potash in a split-split plot design and were managed to simulate pasture conditions.

Increasing the rate of nitrogen applied from 75#/A to 300#/A in three equal split applications resulted in yield increases of approximately 2 1/2-fold for orchardgrass, 3-fold for Kentucky bluegrass, and 3 1/2-fold for Midland Bermudagrass. The yields of Kentucky bluegrass were lowest of all at both levels of nitrogen, and the yields of Midland Bermudagrass were definitely higher than the others at the high level of nitrogen.

Forage from the high nitrogen plots had a higher percent K than that from the low nitrogen plots. The total K removed from the high nitrogen plots ranged from a low of 160# K₂O equivalent for Kentucky bluegrass to a high of 327# K₂O equivalent for orchardgrass.

Varying the level of potassium applied did not influence yields but did influence potassium content somewhat. Orchardgrass was consistently highest in potassium content, Kentucky bluegrass consistently lower, and Midland Bermudagrass always lowest in potassium content.

Title: MIDLAND BERMUDAGRASS FERTILIZATION

Leader: Robert W. Duell

In spite of moisture stress situations that were more severe during the growing season of 1962 than in recent years, the yields of Midland Bermuda-grass continued to increase with increments of 10-10-10 added. This generalization applied to all three locations tested in New Jersey. The difference between yields at the two highest levels of fertilizer applied, viz. 6,000 and 12,000 lb. 10-10-10/A per year, was not statistically significant; the yield curve appeared to level off. When yields from the above plots, fertilized with different rates of 10-10-10 since 1957 were compared with similar rates applied to previously unfertilized Midland Bermudagrass, it was found that the "new plots" yielded from one to two tons more dry matter per acre.

For the first season, five rates of 10-10-10 were compared with five rates of ammonium nitrate supplying equal quantities of nitrogen. The differences between the lower three rates were significant at the 1% level; the differences between the upper three rates were not significantly different. Neither the main effects of source of fertilizer nor the interaction between source of fertilizer and rates were significant. There was a trend, however, for the ammonium nitrate plots to be higher yielding than the 10-10-10 plots at lower rates and lower yielding at the higher rates.

Thoroughbred horses grazed the intended fourth harvest of Midland Bermuda-grass and left different amounts ungrazed. The residue after grazing was harvested with a rotary mower. The horses consumed more of the Midland Bermudagrass that received heavier rates of fertilizers, and more forage from plots fertilized with ammonium nitrate than 10-10-10. Differences within both categories were significant at the 1% level of probability; there were no significant interactions.

Title: GRASS FERTILIZATION STUDIES

Leader: Robert W. Duell

The low rainfall during the late April, and all of May and June, rather severely curtailed production of cool-season species, and Kentucky bluegrass in particular. During drought conditions, the plots that received only ammonium nitrate for the third season appeared particularly stricken; however, such plots recovered when moisture again became sufficient. The stands of orchardgrass were notably thinner under ammonium nitrate treatment than those of Kentucky bluegrass and tall fescue. Plots receiving two applications of 100 lb. N/A from NH_4NO_3 produced only as much dry matter as was obtained from plots receiving a single application of 100 lb. N/A from 10-10-10. Plots fertilized with two 1,000 lb./A applications of 10-10-10 produced 50% more forage than the above.

Orchardgrass was generally higher in protein content than Kentucky bluegrass, and tall fescue was generally lower. Ammonium nitrate-fertilized grass was from 2 to 6.5 percentage points higher than that which received equal amounts of nitrogen from 10-10-10. Interactions between species and fertilizers were significant at the 1% level in three of five cuttings, and the outstanding feature was the exceptionally high protein content of orchardgrass fertilized with ammonium nitrate.

Analyses for phosphorus and potassium are not complete as yet.

Title: INFLUENCE OF PERCENT CALCIUM SATURATION OF THE EXCHANGE COMPLEX
AND FERTILIZATION OF DUTCHESS (NASSAU) SOIL ON ALFALFA
PRODUCTION

Leaders: R. B. Alderfer and C. A. Ramage

Analyses of soil from differently limed and fertilized plots reveal the following:

(1) The effect of different amounts of calcitic limestone applied in 1956 to achieve 65, 100 and 100+ percent calcium saturation of the soil's exchange complex is still reflected in pH measurements which have not changed appreciably since 1960. The pH of the unlimed plots (35% Ca saturated) has remained the same (5.3-5.5) since 1956. The pH of the 65% and 100% Ca saturated plots remains about a half of a pH unit higher (5.8-6.2) and the 100+ percent plot soils one pH unit higher (6.3-6.7). Since 1956 some of the calcium has moved into the upper subsoil as revealed by higher pH values in the 6-12 inch soil layer.

(2) Amount of extractable phosphorus in the surface soil (0-6 inches) has increased with amount of fertilizer P applied annually since 1956. By 1962, a high to very high available P level has been built up in the soil with a pH of 6.0 or above receiving 80 and 160 lbs. an acre P_{2O_5} annually.

Amount of extractable soil potassium increased with amount of fertilizer K applied, and decreased with increasing soil pH due to greater absorption by the more vigorously growing plants on these plots.

Extractable soil magnesium has decreased very markedly from an adequate level (60 lbs. or more per acre) in 1960 to a low to very low level even in the high lime (calcitic limestone) treatments.

(3) Complete loss of alfalfa in all plots by July 1962 may have been due to extreme drouth and insufficient K in the unlimed, unfertilized and the 80 lbs. K_2O per acre fertilized plots; and to insufficient Mg in the unlimed and the limed 160 and 240 lbs. per acre K fertilized plots.

Average Yields of Alfalfa-grass - 1958-62 - lbs. dry matter per acre

<u>Lime Treatment - % Ca. Saturation Soil</u>				
<u>Control</u>	<u>35%</u>	<u>65%</u>	<u>100%</u>	<u>100%+</u>
	4890	6321	6569	6959

Fertilizer Treatments - lbs. NP_2O_5 - K_2D per acre per year

<u>0-0-0</u>	<u>0-40-80</u>	<u>0-80-160</u>	<u>0-160-240</u>
5136	6402	6542	6685

Title: YIELDS OF GRASS PRODUCED BY HEAVY NITROGEN FERTILIZATION,
DAIRY RESEARCH CENTER, BEEMERVILLE, N. J.

Leader: C. H. Ramage, Dairy Science Department

Ten-year-old plots of orchardgrass and reed canarygrass were harvested in 1962. Phosphorus and potassium have been applied in amounts indicated as necessary by soil tests. Lime was added only once during the ten years. The pH values in March 1961, ranged from 5.4 to 6.2. There has been some loss of stand on the high-nitrogen orchardgrass plots, and some infestation with quackgrass. The experiment was concluded in 1962. Ten year results for yield and percent protein were as follows:

Pounds N per acre per year

	0	50	100	150	200	300	400	500	600
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Average Dry Matter Yields in Pounds per Acre per Year
1953-62

Orchard-grass	3847	5132	6277	7191	7737	8408	8451	--	8401
Reed canary-grass	3280	4925	6214	6956	8045	8905	9464	9663	

Average Percent Protein in Forage - 1953-62

Orchard-grass	11.9	12.8	13.1	13.4	16.1	17.3	19.7	--	20.2
Reed canary-grass	13.5	14.3	14.4	14.8	16.5	19.2	21.1	22.7	

Title: MILK PRODUCTION OF DAIRY COWS FED NITROGEN-FERTILIZED
ORCHARDGRASS COMPARED TO ALFALFA

Leader: C. H. Ramage

A three-lactation, double reversal trial has been completed, using 16 cows. Results show that cows on alfalfa will eat more forage dry matter, and produce more milk than cows on nitrogen-fertilized orchardgrass, even though the protein contents of the forages are similar. The following table summarizes the results of the study.

Average 245-day FCM yield and DM intake

Feed	Pounds of concentrate in 245 days	245-day FCM yield	245-day forage DM intake	% Protein in forage
	1b	1b	1b	
Forages				
N-fertilized O. G.		7133	5880	16.1
Alfalfa		8277*	7306**	17.4
Grain levels				
No grain	0	5670	7292	
Low grain	1155	7585	6991	
Medium grain	2310	8009	5864	
High grain	3465	9298	5918	

* Significance at 5% level

** Significance at 1% level

NEW YORK (CORNELL)

Title: BREEDING AND CYTOGENETIC INVESTIGATIONS

Leaders: R. P. Murphy, R. E. Anderson and C. C. Lowe

The studies on heritability of the creeping-rooted character in alfalfa are being continued. The expression of the character in plants of various genetic backgrounds in the older nurseries continues to point up the importance of general plant vigor for expression of the creeping-rooted habit in the earlier stages of plant development.

Small lots of seed have been produced under cage isolation for several synthetic combinations involving four creeping-rooted clones, two clones of Flamande-origin (deep purple flower color), and two white-flowered clones.

Broadcast plantings of these will be made to evaluate agronomic potential and time and level of expression of the creeping habit. Corollary nursery studies of individual plants will be used in determining the inheritance pattern of the character.

The F₁ progenies, including reciprocals, of various high, medium, and low seed-setting clones of Narragansett alfalfa are being evaluated for self, sib, and outcross fertility. The relationships of in vivo pollen-tube growth, ovule number, and abortion of fertilized ovules to seed set are being studied. There is no apparent strong correlation between ovule number and seed set. There is an indication that the frequency of abortion of fertilized ovules is higher in clones low in outcross fertility than in clones high in this respect.

Genetic studies are in progress on white flower color and white seed coat color in alfalfa. These include selfed and crossed progenies from a white-flowered chimaera on a purple-flowered plant.

Single-cross and selfed progenies of orchardgrass are being used to determine the nature of inheritance of several plant characters.

Twelve brome clones were selected from an R₃ generation nursery and used in establishing eleven single-cross production blocks. Three of the clones were selected for agronomic potential and nine for usefulness as genetic markers.

Quantitative inheritance is being studied in alfalfa. Several series of crosses are being used to check theoretical values for double crosses in tetraploid species.

Title: BREEDING AND STRAIN EVALUATION IN FORAGE SPECIES IN NEW YORK FOR IMPROVED FEEDING VALUE, YIELD AND SEASONAL DISTRIBUTION OF FORAGE

Leaders: C. C. Lowe, R. E. Anderson, R. P. Murphy, L. V. Crowder and J. T. Reid (Animal Husbandry) and M. J. Wright and H. A. MacDonald (Agronomy) Cooperating

Alfalfa (1961 Annual Report, page 68)

The 1962 season was very unfavorable for production of forage. Drouth conditions began in May and lasted through mid-August at most trial sites. Season yields were 1-1 1/2 tons/acre below average for alfalfa. In contrast, growing conditions were unusually favorable for seed production of experimental strains.

Second-year forage production was obtained on the series of trials that compare Cayuga and 4 other experimental strains with appropriate checks. Included is the wilt-resistant Flamande strain derived from a backcrossing program of A-225 to several sources of Flamande material. Several trial

sites are located where bacterial wilt is known to exist. At these, an appreciable number of plants in the DuPuits check lot showed wilt symptoms in this second production year. No wilt was observed in the wilt-resistant Flamande or in any of the other varieties. The drouth stress conditions of 1962 were favorable for wilt-symptom expression. Delayed expression of about one year of wilt symptoms on Narragansett compared to DuPuits has been frequently observed at wilt locations. It is fairly certain that all susceptible varieties will incur heavy stand depletion at the wilt-infested test sites in 1963. The yield of wilt-resistant Flamande was essentially equal (less than .1 ton average difference) to DuPuits in the first harvest season, but in the second year WRF was higher at 7 of 8 locations. In side-by-side comparisons a slight difference in regrowth habit was noticeable at several times during the growing season. The trials indicated that there was no practical difference in establishment or regrowth vigor for WRF versus DuPuits and that second-year production of WRF was definitely superior. Since wilt is a doubtful production factor at several of the locations, it appears likely that other desirable factors in addition to wilt-resistance may have been added to the new strain. This variety will be released in the near future. Trials will be continued to compare persistence of WRF with the Cayuga-Vernal type of variety.

Additional data were obtained in 1962 on Cayuga performance. All trials have shown good stands in the fourth harvest year under 3-cutting management. Flamande-type strains were usually quite depleted in this situation whether wilt was present or not. Cayuga had a slight persistence advantage over Vernal and higher season yield due to its faster recovery. Cayuga has performed very well in the lower Hudson valley and in trials in other states to the South of New York. The advantage over Vernal appears to be greater in these warmer environments.

An experimental strain derived from intercrossing plants with the multiple-leaf character showed considerable promise in first-year trial results.

Grasses

The growing season of 1962 was even less favorable for grasses than for alfalfa. First-growth completely exhausted available moisture and little aftermath was produced until late in September. May was dry followed by 2 weeks in June with cool temperatures and a little moisture. The last two weeks of June were warm and dry and maturation proceeded very rapidly during this period. With early varieties and species somewhat delayed and late ones flowering near their normal date, the normal maturity range was shortened. Moisture was so short that applied nitrogen was not fully utilized in trials where grass was grown alone. Under these conditions the yield data have limited significance for assessing production potential.

Feeding Trials

Results from intake and digestion trials with sheep indicate that timothy as a species has a marked superiority in feeding value over both brome and orchardgrass throughout the period when most hay is harvested. Within species, comparisons have shown a consistent advantage for late maturing

varieties. Decline in digestibility with advance in harvest date has been found to be about the same for all forages. There has been a trend for earlier forages to have slightly higher regressions for digestibility on time than late forages during the period measured. This may indicate maturation proceeds slightly faster during the later stages for each forage.

Intake values have generally been found correlated with digestibility values but with some exceptions. Aftermath forages have been consumed at much higher rates relative to digestibility than first-growth forages. Orchardgrass strains have ranked exactly in order of maturity for digestibility values but not for intake. Late strains have not shown a similar advantage in intake in this species as has been found in timothy. While most differences in feeding value between species and varieties have been found consistent over several seasons there have been distinct interactions with seasonal effects which influence maturity expression and the magnitude of feeding value differences.

Comparisons of several indicator criteria of feeding value with trial results indicate dry matter at time of harvest is a better predictor of feeding value than is protein content or crude fiber analysis.

Title: BREEDING AND EVALUATION OF IMPROVED VARIETIES OF FORAGE CROPS
ADAPTED TO NEW YORK AND ADJACENT AREAS OF THE NORTHEAST

Leaders: C. C. Lowe, R. E. Anderson, R. P. Murphy and L. V. Crowder

Evaluation of brome grass polycross progenies in 50' rows under severe cutting management and mixture competition showed marked differences in vigor but little loss in stand during the first harvest year. Drouth conditions slowed growth and resulted in less than normal stress. The breeding objective is to select for increased management tolerance within this species.

Single-crosses among progeny-tested clones of both timothy and orchardgrass are being evaluated in broadcast-seeded trials. Dry matter content at harvest is being used as a maturity indicator in both polycrosses and single-cross progenies. This appears to be a more sensitive indicator than observations on flowering or stage of development. Several synthetics and progenies have consistently shown lower dry matter content than check strains having later anthesis dates.

Cooperative tests with the USDA on alfalfa single-crosses continue to show a number of outstanding combinations for persistence, leaf disease reaction and uniform vigor. These are being used in synthesis of double-cross experimental lines.

Tests on seed increase area effects for component clones of Saratoga brome grass and Essex timothy are also being studied in cooperation with the USDA. Comparisons of restricted polycrosses of Saratoga in broadcast plots for yield and heading expression show a general selection for greater heading

types in progenies produced at 4 western locations compared to Ithaca where the Breeders seed is actually produced. This was not reflected in yields however.

Data are still being accumulated in Ranger and Atlantic alfalfa lots to study effects of seed production areas and procedures.

Title: ALFALFA WEEVIL STUDIES

Leaders: R. J. Prokopy, E. J. Armbrust, W. R. Cothran and George G. Gyrisco

Studies on the summer flight showed that under conditions where alfalfa was not cut until very late, the time of summer flight depended on the maturity of the adults and was coincident with the resumption by the adults of their period of nightly activity following their normal daylight period of inactivity. When alfalfa was cut before the adults were ready for their natural flight, a forced flight occurred in which a large portion of the population flew at light intensities considerably greater than those at which normal activities occur. Males and females flew with equal regularity. At wind speeds of less than 2.5 MPH vertically emplaced flight traps were not reliable indicators of the density of flight. The majority of weevils in flight were found to avoid the flight traps successfully at such low wind speeds. Almost without exception, as soon as the 3,700+ adults actually observed in flight reached a height of 10-15 feet they flew with the wind. This may account for the rapid spread of the weevil into new areas. For the first time in New York, and apparently for the first time in the United States, a distinct fall flight period of the alfalfa weevil was observed.

Soil sampling for adults showed most left the alfalfa fields during late June and early July and spent the summer in the border areas. Fewer than 5% of the adults were below a depth of 3/4" of soil, both in the fields and border areas. Most adults returned during the fall months, the time of return apparently depending on the over-all summer and early fall weather conditions. In their return, the adults preferred fields in which the alfalfa was fully grown to those in which the alfalfa had recently been cut. Following this return to the fields and prior to winter inactivity, females laid an average of 1.0 eggs per each alfalfa stem greater than 2 inches in height. Nearly all of this fall egg-laying occurred in stems of alfalfa plants which had grown since the time of last cutting. The optimum timing of fall control treatments was found to be closely linked with the time of this return of the adults from the border areas to the fields. Early fall treatments apparently reduced the amount of fall egg-laying to a greater extent than late fall treatments. However, late fall treatments gave significantly better over-all control in terms of the amount of fall and spring egg-laying taken as a whole. Dieldrin emulsifiable concentrate applied at the rate of one pound per acre at 4 different times during the fall gave consistently better control than dieldrin granules applied at the same time and at the same rate.

Telodrin granules and emulsifiable concentrate both applied at the rate of 4 oz. and 8 oz. per acre in October and heptachlor granules applied at 1 pound per acre in October all gave excellent control the following spring.

Title: GRASSHOPPER AND PEA APHID INVESTIGATIONS

Leaders: D. D. Hardee and George G. Gyrisco

Dimethoate and Telodrin at 2 and 4 ounces and Phosphamidon at 4, 8 and 16 ounces per acre significantly reduced grasshopper numbers at 2 and 6 days after application, but after 14 days only Telodrin at both rates gave good control.

Imidan, GC3707, NIA5767 and SD7438 at 1.0 pound per acre and Phosdrin at 0.25 pound per acre provided excellent control of the pea aphid up to 13 days after application.

Title: GRASS INSECT INVESTIGATIONS

Leaders: D. D. Hardee and George G. Gyrisco

During the summer of 1962 a series of investigations was conducted with the meadow plant bug, Leptopterna dolabrata (L.) and a large leafhopper, Athysanus argentarius Metc., two very common insects on timothy and other grasses.

Insecticide screening experiments for these insects showed dimethoate, Guthion, GC3707, endrin, Phosphamidon, malathion and lindane at 4 ounces per acre to be the most effective for the meadow plant bug and GC3707, dimethoate, Guthion, DDT and Phosphamidon at 4 ounces per acre as the most effective against A. argentarius.

More oviposition by A. argentarius was noted at 25° and 30°C than at 20°C when females of this species were held at these constant temperatures for varying lengths of time. Adults of A. argentarius were found to survive equally well on Kentucky bluegrass, orchardgrass, brome and timothy, but oviposition occurred only in stems of the latter two grasses. Adults did not survive when caged on alfalfa and red clover, but a large number of eggs were laid in stems of these two crops. In all plants where oviposition occurred, most of the eggs were laid in stems at heights of 2-8 inches above ground. Weekly dissections of 25 females of A. argentarius throughout the summer showed the mean number of eggs per female to be 9.14. Males were found to outnumber the females significantly. The first nymphs were observed about June 1 and adults were not collected after August 7.

Females of the meadow plant bug caged at constant temperatures of 20°, 25° and 30°C showed a marked preference of the higher temperatures for oviposition. Oviposition occurred in stems of orchardgrass, brome and timothy, with most of the eggs being laid in stems of timothy. Oviposition was also found to occur in stems of alfalfa, red clover and sweet clover. Eggs were deposited in all plants from 1/2 to 7 inches above ground, with most of them being laid at heights of 2 to 6 inches. Weekly dissections of 25 meadow plant bug females throughout the first half of the summer showed the mean number of eggs per female to be 16.43. Numbers of males were found to be significantly greater than females, and short-winged females outnumbered long-winged females 10 to 1. The first nymphs were observed about May 1 and adults were not collected after July 15.

Title: EUROPEAN CHAFER STUDIES

Leaders: R. J. Little, Jr. and George G. Gyrisco

Telodrin and dieldrin applied at 1 pound of actual toxicant per acre and Bayer 25141 at 2 pounds per acre were shown to give significant control of 3rd instar larvae of the European chafer. Residue analyses of samples from plots treated with 8 pounds per acre of chlordane dust in 1950 showed that a mean of .032 ppm was present in the soil. These plots are still showing good activity on the chafer larvae. Further analyses of soil from plots of telodrin, dieldrin and thiodan applied in 1960 at 3, 3 and 2 pounds of actual toxicant per acre respectively showed mean residues of 0.345, 0.400 and 0.055 ppm in that order.

The loss of sight as opposed to the loss of antennal lamelli significantly reduced the flight response of European chafer adults in one of four experiments designed to detect such a reduction.

High moisture at low temperatures acting independently appears to reduce the density of the European chafer evening flight.

Although flights artificially produced in phase with field flights are markedly similar in density, those produced 9 hours out-of-phase are much lower in density indicating the presence of rhythmicity not controlled by the environment.

Title: MEADOW SPITTLEBUG

Leaders: R. J. Little, Jr. and George G. Gyrisco

Several of the newer insecticides were tested at a dosage of 2 oz. of actual toxicant per acre to determine their effectiveness against meadow spittlebug nymphs. The materials applied were SD7438, Bayer 39007, Bayer 44646, GC3707,

GC4072, NIA5767, GS13332 and lindane. Only lindane, the standard, provided adequate control.

Title: TARNISHED PLANT BUG STUDIES

Leaders: S. W. Jacklin and George G. Gyrisco

Tarnished plant bugs were controlled for 16 days by lindane, GC3707, and SD7438, all applied at 2 ounces of active ingredient per acre. Bayer 39007, Bayer 44646, GC4072, and NIA5767, applied in the same way, gave no control.

Both field and laboratory experiments indicated that, given a choice, tarnished plant bugs preferred feeding on blooming birdsfoot trefoil to feeding on non-blooming trefoil.

Constant temperature cabinet studies of the tarnished plant bug's preoviposition period showed that both day length and temperature were very important in the female's ovary development. The actual time lapse between last molt and first egg was affected much more by temperature than by day length.

A study of the effect of insecticide drift in small plot field experiments showed that tarnished plant bug populations were depressed at distances up to 75 feet from the margin of sprayed plots. The population levels increased with distance from the sprayed plot margins as residue deposits decreased.

Title: FORAGE LEGUME VIRUS DISEASES

Leaders: L. R. Nault and George G. Gyrisco

Pea-enation mosaic virus, persistent in its vector the pea aphid, was transmitted by this vector after as many as 3 moults, thus definitely establishing a circulative route of the virus through the vector. Presence of the virus in the vector did not have any effect on the fecundity of the adults.

Low transmission in the fall months resulted in the failure of tests relating to the age and form of the aphid as a vector of PEMV. However, the data did indicate that the nymphs are better vectors than the adults.

PENNSYLVANIA

Title: THE GENETICS AND IMPROVEMENT OF PERENNIAL FORAGE LEGUMES

Leaders: R. W. Cleveland and J. L. Starling

Alfalfa: Nurseries established for the breeding of creeping-rooted alfalfa were maintained. Evaluations of most materials growing in the field were not feasible in 1962 because of extreme drought. Materials being studied at present consist of crosses between creeping and hay-type selections and an attempt is being made to isolate higher yielding creeping parents. Presently available creeping strains have low forage yield.

Variety Trials: Evaluation of varieties at several locations in Pennsylvania was continued. New experiments for testing several recently introduced varieties were established at two locations. Several new varieties appear to be adapted for use in this state, and those with adequate testing have been recommended for farm use.

Red Clover: Breeding for resistance to Northern anthracnose was continued. Plants derived as intercross progeny of BC₁ parents were inoculated with the disease organism. Those found to be resistant (23) were backcrossed to plants of the Pennscott variety to produce the BC₂ generation. The back-cross breeding program appears to be adequate to the goal of transferring resistance into Pennscott.

Plant Introductions and Variety Trials of Miscellaneous Legumes: Source nurseries of introduced strains of alfalfa and birdsfoot trefoil were initiated. Extended drought resulted in a high plant mortality and re-establishment will be necessary. Established variety trials of birdsfoot trefoil and red clover gave data of questionable reliability under conditions of drought. New variety trials of ladino clover and red clover varieties had poor establishment in 1962.

Title: CYTOGENETICS OF FORAGE CROP SPECIES AND INTERSPECIFIC HYBRIDS

Leaders: J. L. Starling and R. W. Cleveland

Species Hybridization in Trifolium: Ph.D. thesis studies were completed by J. F. Schwer in which the hybrids of 2n and 4n Trifolium pratense and T. diffusum were investigated as to cytological behavior. Diploid hybrids between the two species showed a high percentage of chromosome pairing but complex associations were common (chains of 3 to 15 members were found per cell). In contrast, both parents showed normal diploid pairing. Tetraploid hybrids had a greater percentage of chromosomes paired as bivalents than did diploid hybrids but many complex associations were also found. A single sesquidiploid hybrid (4n T. pratense x 2n T. diffusum) showed a high degree of preferential pairing of chromosomes of T. pratense origin. The

conclusions from these studies were that the species have a high degree of chromosome homology but complex structural changes of chromosomes have occurred in their evolution. The studies have also indicated that backcross breeding could be utilized to transfer genes from T. diffusum to T. pratense.

Hybrids were obtained from the crosses, 4n T. pratense x 2n T. pallidum and x 2n T. hirtum. No cytological studies were made of these hybrids.

Trisomics in Medicago: Plants with extra chromosomes have been isolated from backcross progenies of triploid x diploid crosses. Ten 17-chromosome and three 18-chromosome plants have been found. Studies have been initiated on different trisomics with the intention of assembling the complete series of chromosome-addition races.

Species Hybrids in Phalaris: A study of embryo sac development has been completed by Mr. T. Devine to identify the causes of differential cross-ability of P. arundinacea and P. tuberosa. It was found that no discernible development of embryo or endosperm occurred when P. tuberosa was the female parent. When P. arundinacea was the female parent considerable but abnormal development of the endosperm occurred, and development of the embryo was retarded.

Title: THE GENETICS AND IMPROVEMENT OF FORAGE GRASSES

Leaders: J. L. Starling and R. W. Cleveland

Orchardgrass Breeding: (1) A broadcast plot trial of polycross progenies of 45 late maturing clones and check varieties was planted. The progenies were provided by the USDA Pasture Laboratory where parental clones were selected for lateness, resistance to common orchardgrass diseases, and vigor.

(2) Plants were evaluated for vigor, disease resistance, and morphological characteristics in a new polycross nursery containing 220 selected clones. Promising clones were identified. (3) A breeder's seed nursery was established for a medium maturity synthetic (Pa. Medium II), which has recently been accepted for variety release. This experimental synthetic has given the top performance of entries in most orchardgrass trials in Pennsylvania over several years. (4) Final evaluations were made in a trial testing the relative yield of component clones, generations of synthetic, and location of seed production for the variety Pennlate. No significant differences were detected among the levels of these variables.

Bromegrass Breeding: (1) Synthetic-2 generation nurseries were established for two experimental synthetics. (2) Yields were obtained in a broadcast plot trial of restricted polycross progenies of parental clones of the above synthetic, the synthetics, and check varieties.

Phalaris Breeding: A source nursery was planted using 42-chromosome hexaploid derivatives of interspecific hybrids between Phalaris arundinacea and P. tuberosa.

Variety Trials: Tests of potentially adapted varieties of reed canarygrass and brome grass were conducted at several locations.

Title: ROOT AND CROWN DISEASES OF FORAGE LEGUMES

Leader: H. B. Couch

This project is in its first year of activation. Field plots of 2 varieties each of alfalfa, red clover, and birdsfoot trefoil have been established. Beginning shortly after seedling emergence, isolations were made at periodic intervals from the root surfaces, and soil immediately adjacent to the roots. It was found that the roots of all species under observation were infected by 3 fungus species (Fusarium roseum, F. oxysporum, and F. solani) one month from the time of planting. No macroscopic evidence of pathogenesis was noted at the time these isolations were made. Later isolations yielded bacteria as well as additional fungus species from the roots.

The pathogenic potential of the 3 Fusarial isolates is being studied in greenhouse and laboratory tests. The influence of soil moisture stress in the readily available range on root infection is being studied by means of cyclic irrigation and a split root technique. Precolonization pathogenic capabilities of these fungi are being determined by observing the influence of mycelial extracts and metabolites on root hairs of alfalfa and red clover.

It is evident that the root systems of forage legumes are well permeated by fungi and bacteria early in their growth. The final process of deterioration, then, is brought about by stresses placed on the plants by the physical and biological environments. The future work of this project will be centered around efforts to identify and determine the relative importance of the various facets of the physical and biological environment in root and crown disease development in forage legumes.

Title: ESTABLISHMENT AND MAINTENANCE OF BIRDSFOOT TREFOIL

Leader: J. B. Washko

The acreage of birdsfoot trefoil continues to expand in the State as farmers gain experience in growing this forage legume. Failure to obtain stands and lack of stand persistence have been troublesome management problems with the species. This legume has been subjected to the same mowing schedule as imposed on alfalfa, for want of better evidence on the most suitable harvest practices. Research was initiated in 1960 to determine what factors affect its growth, productivity and survival.

Establishment seems to be little influenced by levels of plant nutrients supplied at seeding. None of the major fertilizer nutrients, N, P_2O_5 and K_2O , had effect on either spring or mid-summer seedings on relatively fertile soils. Nor did this legume respond to applications of the micro-nutrient, boron. The only fertilizer response obtained was that a single maintenance application of 400 pounds per acre of 0-15-30 produced more forage than the same amount of fertilizer applied as two 200-pound per acre splits in the early spring and after removal of the first hay crop.

Removal of forage during the month of September appears to be injurious. September forage removal for two successive years reduced yields 7% the first year and 65% the second year compared with October forage removal. In addition crown weights of individual plants were reduced 42 to 44% by this September mowing schedule. Apparently this species stores its root reserves and lays down its rhizomes for next year's growth; removal at this period appears to interfere with this process and plant injury results.

It was also found that more forage per season can be harvested from birds-foot trefoil cut at 2-inch rather than 4-inch stubble heights. No advantage in aftermath growth is obtained from leaving a high trefoil stubble. Lowest hay yields were obtained on a monthly mowing schedule and highest hay yields where 6 to 8 week recovery periods were allowed for regrowth.

Title: MAINTENANCE FERTILIZATION OF GRASSLANDS IN PENNSYLVANIA

Leader: L. F. Marriott

The 1962 yields of common orchardgrass topdressed with NPK were 40 to 60% of previous averages as a result of the dry summer. However, the fertilizer response relationships were similar to those of previous years, indicating a more efficient use of available moisture on the better treatments.

Limestone was topdressed in the spring of 1961 on portions of the orchard-grass experiment on Bucks silt loam. The pH of the 0"-3" horizon was increased from 4.5 to 6.4 by September 1962. The available phosphorus as determined by the Pennsylvania Soil Testing Laboratory increased about 50% on the limed and phosphated plots, but there was no increase in available phosphorus where no phosphate fertilizer was used. There was no consistent increase in yields as a result of liming.

In another experiment, finely ground open hearth slag appeared to be nearly as effective as limestone in correcting soil acidity. Waterquenched blast furnace slag applied "as is" has been considerably less effective than limestone. Both types of slag have markedly increased the available magnesium in the soil (Pa. Soil Testing Lab.).

Equal rates of ammonium nitrate, ammonium sulfate or urea were equally effective in increasing orchardgrass yields.

One hundred pounds of N (+PK) applied on orchardgrass in early October was as effective as the same amount applied late in March.

Title: EVALUATION OF NEW FORAGE VARIETIES AND SPECIES FOR DAIRY PASTURES

Leaders: J. B. Washko, E. M. Kesler, and A. L. Haskins

Most Pennsylvania dairymen still rely on pastures to supply the major portion of the feed nutrients required for milk production from May 1 to November 1. Provision must be made not only to supply high quality pasturage but to insure its satisfactory seasonal distribution. Since no one forage species can be depended upon to supply pasturage uniformly throughout the season, farmers have to rely upon different species and varieties with different growth habits and productive periods to meet this need. During recent years plant breeders have developed improved forage crop varieties adapted to the Commonwealth. Information is lacking, however, on the pattern of forage distribution of such new varieties and species so that they can be integrated into a sound pasture system and thus provide a succession of forage throughout the grazing season.

An experiment was initiated in 1961 with lactating Holstein dairy cows to evaluate several new varieties and species of forage crops under grazing conditions. A Vernal alfalfa-Pennlate orchardgrass mixture was found to be the most productive of the 5 pasture swards grazed. Despite the 16 weeks of drought experienced in 1962 this alfalfa mixture produced 4.25 tons of dry matter and 505 cow days of grazing for the season.

Piper sudangrass was the next most productive species under rotation grazing. Pennlate orchardgrass with nitrogen fertilizer was the 3rd most productive variety grazed. Viking birdsfoot trefoil and ladino clover in association with Pennlate orchardgrass were approximately equal in forage productivity and least productive of the 5 swards grazed. Pennlate orchardgrass with nitrogen fertilization and in association with Vernal alfalfa furnished 4 rotational grazings during the season and the other species and mixtures only 3 grazings.

These results indicate that by proper selection of adapted species and new varieties dairymen can provide their cattle with green succulent pasturage even during prolonged droughts. By using several species with different periods of production it was possible to furnish green feed from May 15 through October 31 except for two periods of 2-weeks each, August 1-15 and September 1-15. By providing cattle with pasturage during the drought it was possible to effect cost savings on feed that otherwise would have had to be purchased and conserve on harvested forage needed for winter feeding.

Title: UTILIZATION OF FORAGE BY BEEF CATTLE

Leaders: J. B. Washko, P. J. Phillips and A. L. Haskins

Considerable land in Pennsylvania has been removed from agricultural production entirely or has been relegated to only partial use for pasture. Presently it is in varying stages of neglect; erosion, weeds, brush and scrub trees have taken their toll of this once valuable resource. According to the 1959 Census the Commonwealth has 680,000 acres of idle land and 1,500,000 of unimproved pastureland in this category. Can this land be salvaged from further deterioration and restored to agricultural productivity without adding to our burdening surpluses?

Previous work in the state has indicated that this land can be renovated for grass production and be best used to sustain a livestock economy. While dairying will continue to utilize the major portion of the State's grasslands for feed production, rapid expansion of this industry is unlikely in the immediate future because of the surplus of milk. Beef production on these renovated acres offers the greatest promise because the state is a deficit area as regards meat production and its proximity to large centers of population gives it a definite transportation advantage over meat shipped in from the West.

Accordingly, research was initiated in 1955 to determine the potential of such land when used for quality grass production for conversion into beef. A 190-acre tract of abandoned, unproductive cropland located in Central Pennsylvania was restored for agricultural production with grass by the pasture renovation technique for grazing in cooperation with the Bureau of Correction, Rockview Branch, of the Commonwealth. The tract was divided into 23 pasture paddocks and stocked with yearling beef steers from the first week in May until November 1 or later depending upon forage availability.

It was found that such land can be reclaimed for pasture production. From 3.0 to 5.7 tons of dry matter annually in the form of pasturage and grass silage can be produced on this land. It will carry one steer per acre for the grazing season under rotational grazing with the grass silage available for supplemental feeding in the event of drought. The two legumes, alfalfa and birdsfoot trefoil in grass mixtures were found to be well adapted and persistent under such conditions. Orchardgrass, reed canarygrass and Kentucky bluegrass with nitrogen fertilization were the most productive grasses.

This reclaimed abandoned cropland when renovated for pastures has a potential beef production capacity of 338 to 359 pounds of beef per acre. Supplementing the grass pasturage with 5 lbs. of grain daily increased this to 413 to 423 pounds of beef per acre. Nitrogen-fertilized grass pasturage and legume-grass pasturage were found to be of approximately equal value, for conformation grade differed little whether nitrogen-fertilized grass or legume-grass forage was grazed. Grain feeding with pasturage, generally, influenced dressing percentage but this difference was not always statistically significant over pasturage alone.

Title: EVALUATION OF SORGHUMS, SUDANGRASS AND MILLETS FOR FEED PRODUCTION

Leaders: J. B. Washko and A. L. Haskins

Pennsylvania farmers depend primarily on perennial legumes and grasses to meet their forage needs for livestock. There are times, however, when these species need to be supplemented, particularly as a hedge against summer drought. Sudangrass and forage sorghum are two fast growing drought-tolerant summer annuals that can be used effectively to supplement the perennials. In addition plant breeders have developed sudangrass-sorghum hybrids with higher yield potential than present open-pollinated sudan varieties.

How do these various members of the sorghum family compare for forage purposes in the Commonwealth? The two sudangrass varieties, Piper and Green were tested. Several of the sudangrass-sorghum hybrids have been found to be more productive than the open-pollinated types. Up to 50% more forage can be obtained with the sudan-sorghum hybrids than with the recommended open-pollinated types. These sudan-sorghum hybrids contain more prussic acid than the open-pollinated varieties. If they are allowed to reach a height of 24 to 26 inches before harvest their prussic acid content drops to non-toxic levels. While the sudan-sorghum hybrids are higher yielding than the open-pollinated types they produce coarser forage and have a higher potential for prussic acid development at immature stages of growth. This makes them better adapted for green chop or silage than for grazing purposes.

Forage sorghums have not been found superior to adapted corn hybrids for silage purposes. Some years the better sorghum varieties have outyielded hybrid corn on a dry matter basis. However, because of the higher nutritive value of corn forage when comparisons are made on total digestible nutrient (T.D.N.) yields per acre there is little difference in feed production between corn and sorghum.

How valuable is high population corn for forage? Where high yields of forage are required for green-feeding, corn planted at 200,000 to 300,000 plants per acre can produce 20 or more tons of green forage per acre in 45 to 50 days. However, unless this drilled corn is harvested by the time of tassel emergence it is subject to severe lodging. Double cropping of such corn was found to be impractical. One crop of high population corn planted at 50,000 plants per acre from May 15 to June 15 produced more dry matter per season than an early planting removed for forage in mid-summer and immediately followed by a second planting on the same land.

Corn planted at populations in excess of 50,000 plants per acre does not make good quality silage.

Corn at 50,000 plants per acre will produce from .50 to 1.36 tons more dry matter per acre than conventionally planted corn for silage (20,000 to 24,000 plants per acre) but because of decreased ear size will average less T.D.N. per unit of dry matter at maturity.

RHODE ISLAND

Title: FORAGE CROP ESTABLISHMENT STUDIES

Leader: R. C. Wakefield

Present studies are concerned with evaluation of herbicides as an aid in establishing alfalfa seedings. Chemicals offering advantages for both broadleaf and annual grass control are EPTC, neburon and diphenamid. A combination of 2,4-DB for broadleaf weed control and dalapon for weedy grass control has recently been recommended for legume establishment along with EPTC.

Additional studies are underway to evaluate seeding rate and fertilizer recommendations for establishing legumes, in view of the present availability of herbicides.

VERMONT

Title: FORAGE CROP INSECTS, THEIR RELATIVE IMPORTANCE AND CONTROL

Leader: George B. MacCollom

Studies continued on the correlation of Arthropod and Mirid populations (1961 Annual Report, page 87) and the amount of birdsfoot trefoil seed yielded. The lesser clover leaf weevil Hypera nigrirostris (Fab.) is under observation since its appearance in the state last year.

Title: WINTER KILL OF TREFOIL

Leader: K. E. Varney

A variety trial consisting of nine varieties of trefoil was seeded in the spring of 1961. Seeding rates were adjusted to the pure live seed content of each seed lot and at the end of the seeding year there was an excellent uniform stand of each variety. The winter of 1961-62, caused a great deal of winter injury to stands of legumes throughout the state and this trefoil variety trial did not escape injury. By mid-spring it was evident that there were marked differences, between varieties, in the amount of winter-kill. The extent of winter-injury was measured by estimate of per cent stand in the spring, per cent trefoil in second harvest, and total forage produced (2 cuts).

Variety	Percent trefoil 1st harvest	Percent trefoil 2nd harvest	Seasons total tons DM/acre
Morshansk (Leo)	93	78	2.40
Empire	73	83	2.40
Fargo	58	83	2.37
*Hybrid (Empire)	41	73	1.64
Viking	18	53	.80
*Hybrid (European)	14	57	.78
4X Narrowleaf	9	42	.53
Mansfield	6	36	.39
Granger	1	10	.05

* Hybrids of L. corniculatus and L. tenuis 4X

Title: SHEEP GRAZING TRIALS WITH BIRDSFOOT TREFOIL

Leaders: G. M. Wood and K. E. Varney

Disappearance of trefoil and or encroachment of weeds, Kentucky bluegrass, and quackgrass into all paddocks made termination of this study (1961 Annual Report, page 88) advisable. After two years of grazing by sheep (three years after seeding) trefoil populations were finally determined from separated botanicals. Results are as follows:

Variety	Annual treatment				
	Four grazings	Three grazings	Early cut hay +aftermath grazings	Med. cut hay +aftermath grazings	Late cut hay +aftermath grazings
Percent trefoil - dry matter basis					
Polyploid					
Narrowleaf	3.7	3.0	0.1	0.4	1.5
Narrowleaf	1.0	0.5	3.5	1.2	1.1
Hybrid	2.2	1.3	11.6	5.1	0.6
Empire	23.5	17.1	25.6	14.1	17.1
Mansfield	6.6	9.8	22.5	3.3	18.2
Mean	7.4	6.3	12.7	4.8	7.7

Satisfactory legume populations, although initially excellent, were not maintained regardless of trefoil or treatment. However, Empire persistence was consistently better, in part perhaps due to its superior hardiness.

Early cut hay followed by aftermath grazing favored trefoil persistence more than the other treatments.

Title: NITROGEN STUDIES WITH GRASS

Leader: K. E. Varney

A study of effects of split applications of nitrogen on the yield of grass (1961 Annual Report, page 88) was continued. Results at the end of the second year are as follows:

Lbs. N. applied		Yield - tons DM/acre*		
Spring (May 4)	After 1st cut (June 25)	1st harvest	2nd harvest	Season total
75	75	3.32	1.68	5.00
50	100	3.22	1.71	4.93
100	50	3.26	1.62	4.88
50	50	3.25	1.55	4.80
100	0	3.28	1.26	4.54
0	100	2.66	1.66	4.32
50	0	3.13	1.09	4.22
0	50	2.56	1.44	4.00

* Caldwell plots 1961; Bostwick plots 1961-62.

Title: EMBRYO CULTURE IN LOTUS SPECIES AND SPECIES HYBRIDS

Leaders: A. Gershoy and Elaine Barnes Bonnette

Studies were continued (1961 Annual Report, page 86) using modifications of media and of adjuncts. The distorting effects of auxins on developing seedlings were rather extensive. Species-hybrids embryos, younger than those in the torpedo stage, have not grown in a variety of media. In the case of one self-fertile species, complete embryo development was secured from a stage shortly after fertilization: some of the mature embryos germinated in situ.

WEST VIRGINIA

Title: FACTORS INFLUENCING LOSSES FROM ROOT ROTS OF FORAGE LEGUMES

Leaders: Edward S. Elliott and Robert E. Baldwin

Isolations from red clover roots indicated that Fusarium spp. were more often associated with decayed roots than were other genera of fungi. The predominant species of Fusarium isolated were F. oxysporium, F. roseum, and F. solani. Death of plants infected with Fusarium spp. with or without extensive insect damage frequently occurred following the 1st cutting and was the greatest if the cutting was made during a dry period.

Field plot studies indicated that under some conditions, as many as 25 percent of the red clover plants in a "normal" stand could be removed without appreciably affecting the total yield of forage.

Although parasitic forms of nematodes are present in red clover stands where extensive root rot losses occur and may contribute to over-all damage, no definite relationship in kinds or numbers have been associated with these losses.

Title: DISEASES OF FORAGE GRASSES

Leader: Edward S. Elliott

One hundred and thirty-one selections of Kentucky bluegrass of domestic and foreign origin were screened for resistance to four fungus diseases. The four pathogens involved were Erysiphe graminis, Helminthosporium vagans, Puccinia graminis, and P. poae-sudeticae. Numerous individual selections were found having resistance to one disease and combined resistance to two diseases. Relatively few were found with combined resistance to three diseases and only six selections had apparent resistance to all four diseases.

Title: ALFALFA INSECT CONTROL STUDIES IN WEST VIRGINIA 1960-63

Leader: C. K. Dorsey

Late fall applications of granular formulations of heptachlor, dieldrin and telodrin were made (11-14-61) on alfalfa plots (1/8 A., X 2) to determine the comparative effectiveness of these materials, applied at this late date, in controlling alfalfa weevil. All materials gave satisfactory (89%) to excellent control (98%) of this pest. Dieldrin was used at 0.5 lb. actual per acre; heptachlor at three rates, 0.5, 0.75 and 1.00 lb. per acre

(comparable control with each rate) and telodrin which was used at 0.25 and 0.5 lb. per acre gave control results at both levels, equal to the best achieved with the other materials.

The leafhopper, mirid bug, aphid, and grasshopper complex control studies started in 1960, were continued in 1961 and 1962; in addition to insecticide treatments, foliar nutrient sprays were also included in these plots. The evaluations from the foliar nutrient spray plots (18-33-18, 0-0-62 and 46-0-0) have not been completed and the 1962 insecticidal applications evaluations are incomplete at this time. A preliminary summary of these incomplete evaluations, based on 2 weeks post-treatment effectiveness with the designation "satisfactory control" placed at 70%, shows that certain materials were obviously more effective in controlling specific insects than others. The sprays were applied in May and again in August with an average 125-150 p.s.i. at about 35 gal. per acre. In most cases the population sampling was conducted (aver. 50 sweeps each plot each sampling) 1, 2, and 3 weeks after treatment.

Insecticides giving satisfactory Control for
two weeks after Treatment (sprays) at the
Indicated Rate of active per acre.

Material	Aphids	Leafhoppers	Mirids	Grasshoppers
SD-7438 (0.5 lb.)	X	X	-	X
#43064 (1.0 lb.)	X	-	X	*
Guthion (0.25 lb.)	X	-	-	*
(0.5 lb.)	X	-	X	*
Phosdrin (1.0 lb.)	X	*	*	*
Parathion (0.2 lb.)	X	X	X	*
Methoxychlor (0.75 lb.)	X	X	-	*
Zectran (0.75 lb.)	-	-	-	X
Dimethoate (1.0 lb.)	X	X	X	*
Malathion (1.0 lb.)	X	-	-	X
Diazinon (0.5 lb.)	X	-	-	X

Material	Aphids	Leafhoppers	Mirids	Grasshoppers
Tiguvon (#29493) (1.5 lb.)	-	-	-	X
Cynem (#18133) (1.5 lb.)	-	-	-	X
Dylox (1.0 lb.)	-	-	-	X
Sevin (1.0 lb.)	X	-	-	X
Thiodan (0.5 lb.)	-	-	-	X
Di-Syston (1.0 lb.)	X	*	*	*

X = Satisfactory

- = Not satisfactory

* = No evaluation

Title: THE PERFORMANCE OF SEVERAL ALFALFA VARIETIES GROWN UNDER
DIFFERENT CLIMATIC CONDITIONS, WITH EMPHASIS ON THE
INFLUENCE OF FALL CUTTING

Leaders: Gerald A. Jung and William T. Carlson

Plots were harvested according to schedule during 1962. Droughty conditions during the summer resulted in slight yield reductions at Wheeling, Reedsville, and Terra Alta and severe yield reductions at Morgantown and Martinsburg. The Martinsburg experiment clearly showed how much more drought tolerance alfalfa has than most forage species. While corn was dying and most perennial grasses were turning brown, some of the alfalfa plots were harvested four times.

The stands of DuPuits appeared to be seriously reduced by disease. Plant pathologists are attempting to identify the causal organism.

Supplementary studies at Point Pleasant confirmed earlier studies on establishment and fall management. In both instances, DuPuits established poorly compared to Vernal, and late October cutting resulted in low yields. The response to a late October cutting in the year of establishment probably can be attributed to weed competition.

Most of the alfalfa stands in this study have persisted well during the four year period. This is in contrast to the situation on many West Virginia farms. Two factors which can account for this difference are: (1) Amount and kind of fertilizer used in topdressing and (2) fall grazing.

Title: BIOCHEMICAL STUDIES ON COLD-RESISTANCE OF ALFALFA

Leaders: G. A. Jung and W. T. Carlson

Cold resistance data which were collected over a two year period on (a) whole plants, (b) crowns with and without buds, (c) steles with and without crowns and (d) buds of hardy and non-hardy tissue are presently being analyzed statistically to determine: (1) The kind of relationships that exist among the various plant parts. (2) If summation of plant parts is equal to whole tissues. (3) The influences of rate of development (weight) of each plant part on cold resistance development. (4) The influence of minimum and maximum temperatures and snow cover on cold resistance development.

Qualitative amino acid analyses are being made on certain tissues to determine if any major differences exist among plant parts or between varieties. After using several identification tests, 13 amino acids were identified but several still remain unidentified.

Title: RATE AND TIME OF APPLICATION OF K FERTILIZER IN RELATION TO YIELD
 AND LONGEVITY OF ALFALFA STANDS

Leaders: G. G. Pohlman and C. D. Reese

Yield records were obtained from four experimental fields to which potassium fertilizers were added at various times and rates. There was no effect on the two fields at Morgantown and Lewisburg which were first treated in 1962. Maintaining the available potash at 400 pounds per acre resulted in a slight increase in yield on plots on Wheeling loam at Point Pleasant. There was no effect on the plots at Wardensville. Alfalfa samples from all plots have been collected for analyses for K_2O content.

Soil samples taken at 0-3" from alfalfa demonstration plots showed an increase in stand from the application of potash fertilizer when the available soil potassium in the check plot was very low or low but none when available soil potassium was high or very high. Available potassium in the soil was increased by application of 100 pounds or more of K_2O when initial available potassium was very low or low.

USEFUL TECHNIQUES

U. S. Regional Pasture Research Laboratory

Self-irrigating Greenhouse Pots

Read et al. described a self-irrigator for greenhouse pots in Agron. Jour. 54 (5):467-8, 1962 which was effective at low soil moisture tensions. Pasture Laboratory personnel have also used a similar but less-refined self-irrigator with satisfactory results at soil moisture tensions of about 50 cm. It was very useful in studies of plant competition where maintenance of low soil moisture tension by surface irrigation is quite difficult. The self-irrigator described by Read et al. 1962 is recommended for such situations.

Materials Available for Porous Wall Root Segregation in Competition Studies

Porous, ceramic filters are available in varying sizes and shapes with pore sizes rather well-defined. These are commonly sold for use as bacterial filters, and soil tensiometer bulbs. They were found to be quite useful in studies of root interactions between competing forage species. Another type of inert material now available is a porous polyethylene with an average pore size of 50 microns.

A Simple, Inexpensive Water Bath for Reducing Maximum Soil Temperatures of Greenhouse Cultures Conducted During the Summer Months

At times, it is advantageous to run small experiments in the greenhouse during the summer months, but high temperatures usually prohibit the use of cool season species. The water bath described below can be constructed on the top of a wooden greenhouse bench in about 4 hours at a materials cost of less than \$10.00. Furthermore, second-hand materials may be used.

The water bath consisted of a box (16 ft x 3-1/2 ft x 5-1/2 in) lined with clear polyethylene (3 mil) and filled with tap water. The tap water entered the bath through the fine holes in a 50 foot long sprinkler hose folded in a pattern to give maximum water distribution in the bath. This arrangement resulted in uniform temperatures throughout the entire water bath. It was necessary to hang weights on the hose to keep it in place. The flow of tap water through the bath can be increased to assure little temperature change on hot days. At University Park in July 1962, it was necessary to run only a small stream of water (about the size of a pencil) through the sprinkler hose from 10:00 a.m. to 5:00 p.m. to maintain

soil temperatures within gallon pots at less than 80°F when air temperatures in the greenhouse were greater than 100°F. The efficiency of the bath can be increased by covering the space between pots with waterproof insulating material which would also reduce the possibility of algal growth in the water bath.

VERMONT AGRICULTURAL EXPERIMENT STATION

Soft Stem Cuttings of Zigzag Clover, Trifolium Medium L.
(T. R. Flanagan and A. Gershoy)

A reliable technique (1961 Annual Report, page 95) for volume production of herbaceous stem cuttings of zigzag clover was developed. Sections taken from various portions of the soft stem were rooted in several media under mist propagation devices. The most successful method utilized terminal stem sections, treated with 0.1 percent indolebutyric acid powder, placed in vermiculite or medium fine gravel, and maintained under intermittent mist conditions. Root initiation was pericyclic and mostly peripheral to the lower cut stem surface or callus.

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